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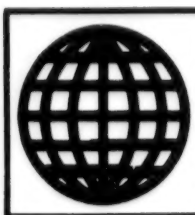

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Science & Technology

China

Trends in the Electronics Industry in the Chinese Economic Sphere

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Trends in the Electronics Industry in the Chinese Economic Sphere

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Chapter 2. State of Chinese Industry and Economy Making Rapid Strides

2.1 Economic Changes From the Cultural Revolution to the Tienanmen Incident

2.1.1 Progress of Heavy Industry and Agriculture

China's industrial production has made phenomenal strides in the 10-year period between 1978, which saw the purge of the Gang of Four and China's decision to initiate a policy of economic openness with the outside world, and 1989, when the Tienanmen Incident occurred.

In the field of agriculture, production output only increased 10% from the 1950s until 1978. This was due to the introduction of severe agricultural policies under Mao Zedong, whereby, even if farmers increased output, government-supported population growth, industry-first policies and the government's "Equalized Allotment" system ensured that farmers' incomes did not increase, thus lowering their will to work harder.

The purging of the Gang of Four in December 1978 brought the curtain down on the Cultural Revolution. Taking advantage of this opportunity, Deng Xiaoping pounded out policies aimed at opening the Chinese economy to the outside world, and reversed government policies regarding the impoverished agricultural sector. The People's Communes that symbolized the government's agricultural policies up until that time were broken up, and were replaced by a system of small, family-run farms and household-based contract farming. This greatly spurred the farmers' will to increase production, which in turn led to the rapid development and growth of rural enterprises and the amassing of millions of yuan by newly-emerging entrepreneurs.

2.1.2 Transition to Rural Enterprises

The agricultural reforms of 1978 broke up the People's Communes, and wrought changes in the administrative units that had been in effect up until that time. Those elements that had been managed by the People's Communes and Production Battalions became the progenitors of rural enterprises.

After 1984, all enterprises located in rural communities, including both those run by individuals and those managed by farmer's cooperatives, became known as rural enterprises.

Due to the rural enterprises' ability to freely manufacture and market goods, and their pursuit of profits, the productivity and earnings ratios of these undertakings were markedly higher than those for agricultural operations to date. Whereas these rural enterprises initially dealt in agricultural products, spinning and weaving materials and construction materials, today they are involved in fields of all sorts. Rural enterprises account for roughly 25% of the rural labor force, with the total number of employees at these concerns exceeding one billion in 1992. And the most important aspect of these rural enterprises has been their indisputable role in furthering the development of China's central and southern economic zones, which are promoting reform and the opening of China. The reason for this is the expansion of rural enterprises from labor-intensive to knowledge-intensive industries in cooperation with overseas Chinese investors.

However, China's rural enterprises also have their drawbacks. These include a large number of problems that will have to be resolved in future, such as poor production efficiency, weak international competitiveness for the amounts of foreign currency they earn, and the inability to cope with business fluctuations.

2.2 State of the Chinese Economy From the Tienanmen Incident Until Present

2.2.1 Establishment of Special Economic Zones and Economic Growth

Following the demise of the ill-fated Cultural Revolution, China was finally able to turn its attention to reforming its economy. In addition to commencing active participation in the International Monetary Fund (IMF) in April 1980, and in the International Bank for Reconstruction and Development (IBRD) and the International Development Association (IDA) in May of that same year, China also set up special economic zones in Shenzhen, Zhuhai and Shantou in August 1980, and in Xiamen in October of that same year.

Then in April 1988, China pushed forward intently with policies aimed at opening the coastal regions of southern China, including the island of Hainan, to trade with foreign countries. China also established one after the other economic development zones and free trade zones similar to its special economic zones, and rapidly pounded out policies designed to accelerate the country's economic growth. These policies were aimed at acquiring foreign currency, privatizing state-run enterprises, establishing a stock market system, promoting the liberalization of pricing, exempting 60% of all production materials from state controls, relaxing regulations governing every aspect of free trade and foreign currency acquisition by rectifying coastal trade and favored nation trade policies, and opening domestic markets to foreign trade.

These efforts helped China's economy bounce back following the temporary setbacks incurred as a result of the Tienanmen Incident, and were proof of China's

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intentions, verbalized by Deng Xiaoping in his South China address, of catching up with the advanced nations of the world economically.

At the third session of the 14th Party Congress of the Communist Party of China held on 14 November 1993, the national government decided to come to grips with the problems and issues facing the country's 10-step socialist market economy system. In this decision, China clearly indicated that it intends to promote a market-oriented economic system, to introduce corporate management practices that are capitalistic in nature, to stay out of the ultimate running of businesses and setting of prices, and to allow the Chinese economy to adjust to macroeconomic forces.

2.2.2 Transitions of Agricultural and Industrial Output and the Gross National Product

Table 2.2.2.1 Transition of Gross National Product (Unit: 100 million yuan)

	Gross agricultural output	Industrial output	GNP
1986	4,013	11,194	9,696
1987	4,676	13,813	11,301
1988	5,865	18,224	14,068
1989	6,535	22,017	15,993
1990	7,662	23,924	17,695
1991	8,157	28,248	20,193
1992	9,085	37,066	24,036
1993 (estimate)	9,421	44,294	31,380

Source: China's Statistics Yearbook

The status of farming and farmers in China improved considerably after 1978, but there is still a big gap between the socioeconomic standing of farmers and city dwellers. This gap has begun to give rise to dissatisfaction on the part of the farming population.

Table 2.2.2.2 Transitions of City and Rural Populations and Incomes

	1985	1990	1991	1992
Rural population	810 million	840 million	850 million	850 million
City population	250 million	300 million	310 million	320 million
City residents' savings	1,622 yuan	7,034 yuan	9,110 yuan	11,545 yuan
City residents' income for living expenses	685 yuan	1,387 yuan	1,544 yuan	1,826 yuan
Rural residents' net income	398 yuan	686 yuan	708 yuan	784 yuan

Source: China's Statistics Yearbook

According to the initial Eighth Five-Year Plan (1991-95), GNP figures for the period are expected to exhibit an average annual growth rate of 6%, gross agricultural output is expected to show an average annual growth rate of 3.5% and gross industrial output is expected to exhibit an average annual growth rate of 6.5%. The outlook put forth in the 10-Year Plan covering the period from 1991 to 2000 sees the average annual growth rate for the GNP remaining the same as that expected during the Five-Year Plan, i.e. 6%, but the average annual growth rate expected for gross agricultural and industrial output combined works out to 6.1%, with gross agricultural output seen as accounting for 3.5% and gross industrial output expected to account for a high 6.8% of that combined average annual growth rate. This places the expected average annual growth rate for industrial output higher for the 10-Year Plan than for the Five-Year Plan.

These figures unintentionally reveal the fact that while China has adopted policies actively aimed at emphasizing agriculture and improving the status of the farmer by the year 2000, in actuality, it will be devoting its energies toward increasing industrial output. Viewed from a different angle, this projected trend could indicate that China intends to start moving its rural labor force to the cities, to increase its exports and to transform itself into an advanced economic nation.

2.2.3 National Financial Trends and the Domestic Economy

China's 1992 national finances showed revenues of 418.9 billion yuan and expenditures of 442.7 billion yuan, working out to a loss of 23.8 billion yuan. The biggest sources of national revenues were various taxes, principal among which were revenues derived from taxing industrial and commercial activities (74.9%) and from redeeming debt (15.9%).

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National expenditures consisted principally of the cost of basic construction work (18%), expenses related to education (10.8%), government administrative and management expenses (9.7%), national defense (8.5%), expenses related to agricultural operations (6%) and national debt (9.9%). The major portion of construction-related expenditures took the form of investments in building up China's infrastructure. China's national finances have been in the red almost every year since 1979.

The main factor behind these almost constant losses is the drastic reduction since 1979 of the total amount of revenues earned from taxing industrial and commercial activities and the payment of corporate revenues to the government, the equivalent of corporate taxes. The principal reason for this drop in tax revenues is the payment and taxation system established previously and promoted following the 11th Party Congress of China's Communist Party. This system comprises two policies—a residual profits policy and a profit contract policy—which allow state-run enterprises to retain a fixed portion of their profits.

Meanwhile, the various protection policies adopted by the Chinese government, such as the guarantees on low-priced supplies, various benefits and financial subsidy programs, are bloating its expenditures. Payments accompanying increases in the purchase-delivery backspread, subsidies and excess purchasing, plus the subsidies paid to enterprises recording losses have reached huge proportions. These expenditures account for over 17% of national revenues.

This approach to managing companies like the state-run enterprises of the past, i.e. on the coattails of the national government, is putting a severe strain on China's national financial situation. And another factor that must not be overlooked is inflation. The inflation rate in China is keeping about half of all state-managed enterprises in the red. Extremely bad investments, and the continued rapid rise in raw materials costs and wages are apparently deepening China's financial difficulties.

There is talk that wages have increased between 20-50% in some places. This puts the Chinese government in the extremely difficult position where it desperately needs to tighten up its money policy, but if it tightens up too much, the state-run enterprises that account for 70% of the government's revenues will have a hard time getting loans, which in turn will impede their business activities, subsequently further reducing the government's tax revenues.

2.2.4 Active Foreign Economic Policies and Foreign Currency Acquisition

Despite its various domestic problems, ever since the Party Congress of 1978, China has been striving to switch to a policy of free trade with overseas nations. Of the measures taken in this regard, those that deserve special mention are the Chinese government's approval of free economic activities, its creation of special economic zones in Shenzhen, Zhuhai, Shantou, Xiamen, and Hainan, and its further establishment between 1984-85 of economic and technology development zones and free trade zones.

In addition to working energetically to open up its markets to foreign trade and foreign investment, China has been introducing the superior technologies and modern business practices used by the advanced nations. These moves enabled China to achieve total imports and exports valued at 115.4 billion yuan in 1990, a 5.6-fold increase over the 20.6 billion yuan worth of imports and exports recorded in 1978. In 1992, the value of China's overall imports and exports worked out to an even higher 165.6 billion yuan.

China's GNP grew 12.8% in 1992, and recorded a growth rate of 13.4% in 1993. Also, in 1992 direct foreign investments in China on a contract basis reached $58.1 billion, working out to a 4.8-fold increase over the year previous. Actual investments totalled $16.2 billion.

It is interesting to note that total foreign investments in China from 1979 to 1991 worked out to $52.3 billion, or less than the amount of foreign investments made during the one-year period of 1992. This sudden jump in investments is not that surprising, however, when you realize that the overwhelming majority of these investments were made from Hong Kong. Of the 48,764 contracts made during 1992, more than 65% were with Hong Kong investors, with Hong Kong capital accounting for 67% of these investments on a value basis.

Each of the cities designated by the Chinese government for opening to foreign trade and investment boasts total industrial output on a value basis that is well above the nationwide average. And we mustn't overlook the fact that it is not China's state-run enterprises that are supporting the growth rates exhibited by these cities, but rather the cooperative, joint venture and wholly-owned foreign-capital firms operating there.

2.2.5 Foreign Relations With an Eye Toward the Return of Hong Kong

China's policy of opening its economy to the outside world is aimed first and foremost at promoting its domestic economy, but China also has big plans for Hong Kong when it is eventually returned.

Great Britain is scheduled to return Hong Kong to China on July 1, 1997. Hong Kong's per capita GNP as of 1991 worked out to $12,433, or more than 38 times that of China. After the return of Hong Kong, China is believed to be contemplating the creation of a Greater China, or all-encompassing Chinese economic policy that incorporates Taiwan as well.

The reasons for this are the fact that the Chinese in China, Hong Kong and Taiwan belong to the same race, and share the same cultural background, and that the Chinese in Hong Kong and Taiwan look very attractive

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to those on the mainland because of their much greater financial, technological, management and overseas business capabilities. At present, Hong Kong is suffering from a severe shortage of labor, and Hong Kong-based manufacturers are shifting their production operations to Guangdong Province and other regions inside the South China economic zone as a means of supplementing labor and lowering production costs.

Hong Kong manufacturers are reportedly employing 3 million workers in Guangdong Province alone. Products manufactured inside China, brought back to Hong Kong and then re-exported from Hong Kong currently account for 75% of Hong Kong's total exports. Of these, 60% are products made in Guangdong.

This is the kind of intimate relationship Hong Kong has developed with China. And for its part, China views Hong Kong as an essential base for funds procurement, business talks and investments.

Politically speaking, there is concern over the friction that has arisen between China and Governor Patten regarding Hong Kong's return. This no doubt puts the United States in somewhat of an awkward position, but if China makes some concessions in the realm of human rights, then the view is that the United States will extend the most favored nation status it has already bestowed on China. The U.S. also appears poised to give maximum support to China's membership in the GATT. Thus, even though the return process may experience some heavy seas, the scenario is unlikely to change.

2.2.6 Practical Industrial Policies and Future Tasks

With Deng Xiaoping's South China address in early 1992 as a turning point, China pushed forward with the acceleration of its economic reforms and the expansion of its open door policies, with the result that in 1993 its GNP is expected to increase 13.4% over previous year figures, investment in fixed assets is seen as going up 50.6% compared to the year prior, and industrial output is expected to rise roughly 19.5%. But China still has a lot of problems that must be resolved.

On New Year's Day 1994, the government commenced putting into effect the decisions made during the November 1993 Party Congress by unifying its dual exchange rate, implementing new taxes and strengthening the independence of the central bank.

However, numerous tasks remain. China must do something about its overheating money market. Although the authorities tightened up on the money market in June 1993, they abandoned these measures after just three months. Solutions must also be sought for related problems, such as the chaotic loan policies of banks, which have resulted in vacillating speculation; for the speculation in real estate, stocks and the huge amounts of funding and loans being pumped into thus far futile attempts to build up an infrastructure; and regional governments' penchant for acting on their own.

The Chinese government is first and foremost pushing for improved relations with the United States, and is engaged in political negotiations aimed at gaining early entry into the GATT and acquiring economic support. In the economic realm, the government is strongly promoting a market economy as it tries to steer a course to double-digit GNP growth; formulating anti-inflation measures; taking steps to energize state-run enterprises; pushing to expand development from the coastal regions inland; and striving to eliminate economic differences that exist between regions. On the social front, China is striving to improve the lives and livelihoods of its citizens via the construction of an infrastructure; working to solve troubles rooted in ethnic differences; and emphasizing the fostering of tertiary industries.

Chapter 5. Trends in China's Semiconductor Industry

5.1 Overview of the Chinese Semiconductor Industry

5.1.1 Evolution of the Chinese Semiconductor Industry

The history of China's semiconductor industry can be traced back to just after the construction of the New China in 1956, when, under the leadership of the late Zhou Enlai, the government chose semiconductors as one of the six scientific and technological areas to be stressed and commenced developing these devices. In 1957, a semiconductor laboratory was established inside the Beijing Electronics Workshop and work was begun on producing prototypes of transistors and diodes. By the early 1960's, China had begun to mass produce transistors and diodes. A group from Shanghai Fudan University commenced work on a prototype integrated circuit (IC) in 1960, and by 1965, China had begun manufacturing ICs. China started mass producing ICs towards the end of the 1960's, and began fabricating large-scale-integration (LSI) devices around the mid-1970s. When you consider that Japan started manufacturing semiconductors in 1954, China's entry into this field was not late by any means. However, with the onset of the Cultural Revolution, the exchange of information with other countries was shut off and the enforcement of COCOM regulations made it difficult if not impossible for China to acquire semiconductor manufacturing equipment. These factors combined to delay China's progress in the field of semiconductors considerably vis-a-vis that of Japan and other nations. Realizing the need to make up for lost time, in both its Seventh Five-Year Plan that commenced in 1986, and its Eighth Five-Year Plan that got underway in 1991, China stipulated semiconductors as the pillar of its electronics industry, and has been vigorously pushing forward with the introduction of foreign technology and the establishment of technical tieups with foreign capital.

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Table 5.1.1.1 Evolution of China's Semiconductor Industry

Era	Description/Technical Level
Germination period	1956—Semiconductors chosen as one of six major science and technology fields.
	1957—Semiconductor lab set up at Beijing Electronics Workshop. Prototypes of transistors and diodes developed.
Growth period	1960—Twelve-device germanium substrate IC fabricated at Shanghai Fudan University.
	1964—Commenced manufacture of silicon semiconductors.
	1965—Commenced production of ICs.
Slump Period	1975—Over 100 semiconductor plants in operation, 25 of which were IC manufacturing plants.
Reform/development period	1979—Developed 1K DRAM
	1981—Developed 256-bit SRAM and 16K DRAM
	1982—Established IC manufacturing bases in Shanghai and Beijing
	1983—Set up VLSI research institute-cum-production plant in Wuxi
	1986—Developed 2K EEPROM, 64K DRAM and 16K SRAM
	1987—Established composite wiring design center in Beijing
	1989—Bell Laboratories, Philips and Motorola establish IC production plants
	1991—NEC sets up IC plant in Beijing

Source: EIAJ Survey Team

5.1.2 Current State of China's Semiconductor Industry

As pointed out in Table 5.1.2.1, as of 1992, there were a total of 338 semiconductor manufacturers operating in China, of which 23 were state-run IC producers, 310 were state-run discrete device makers and five were foreign capital-affiliated joint ventures or wholly-owned foreign capital operations. With the exception of the foreign capital-affiliated firms, the majority of these semiconductor enterprises are small- and medium-scale operations, most of which are concentrated in Beijing, Shanghai and Guangdong Province. China also has a total of 13 semiconductor research institutes.

Table 5.1.2.1 Number of Semiconductor Firms

	1990	1992	Remarks (as of 1992)
Foreign-capital joint ventures/investments	2	3	Bell and Philips (Shanghai), NEC (Beijing)
Wholly-owned foreign capital operations	1	2	Motorola (Tianjin), Sanyo (Shekou)
State-run IC manufacturers	29	23	For information on principal enterprises, see "Semiconductor Industry Trends"
State-run discrete device makers	340	310	
Total state-run enterprises	369	333	
Total semiconductor manufacturers	372	338	

Source: EIAJ Survey Team

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The total number of workers employed at state-run semiconductor enterprises works out to 130,000 at discrete device makers (of which 16,000 are engineers) and 21,000 at IC manufacturers (of which 4,300 are engineers) (see Figure 5.1.2.2).

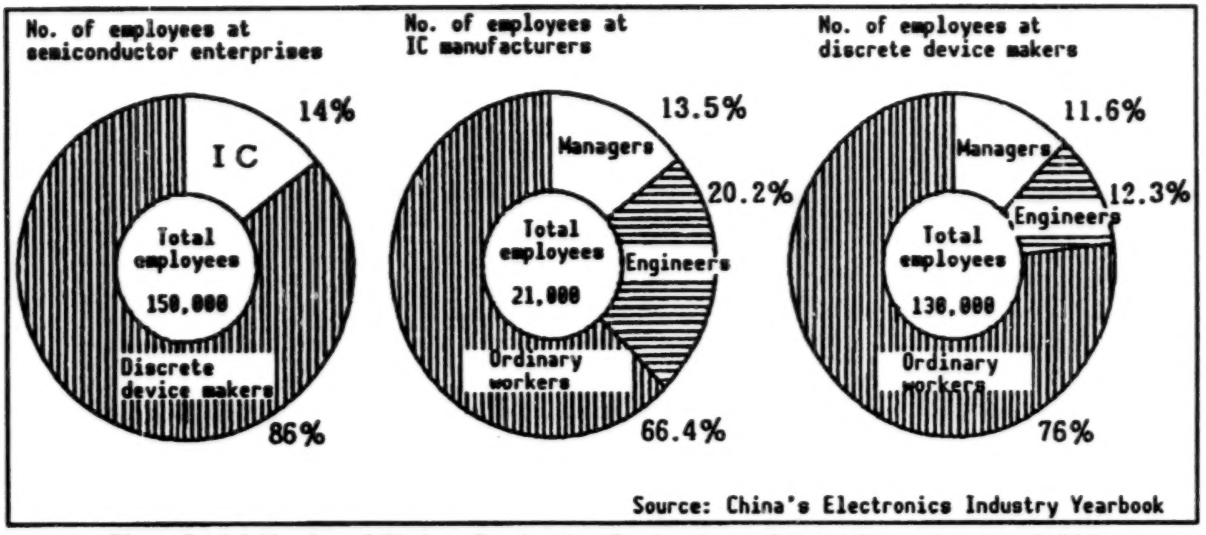

Figure 5.1.2.2 Number of Workers Employed at Semiconductor-Related Enterprises (as of 1992)

Production output by China's state-run semiconductor enterprises totalled 4.98 billion yuan (roughly ¥64.8 billion) in 1992, 620 million yuan (roughly ¥8.1 billion) of which was accounted for by ICs, with the remaining 4.36 billion yuan (roughly ¥56.7 billion) accounted for by discrete devices. This worked out to less than 2% of semiconductor production in Japan for that same year (see Figures 5.1.2.3 and 5.1.2.4). Demand for semiconductor devices in China during 1992 on a value basis reached 7.9 billion yuan (roughly ¥102.7 billion). With domestic production unable to keep up with demand, China was forced to rely on imports (including smuggling) for the brunt of its semiconductor needs. Demand for discrete devices was pretty much on a par with domestic production of these devices, which meant that, with the exception of specialized products, domestic production was capable of meeting demand.

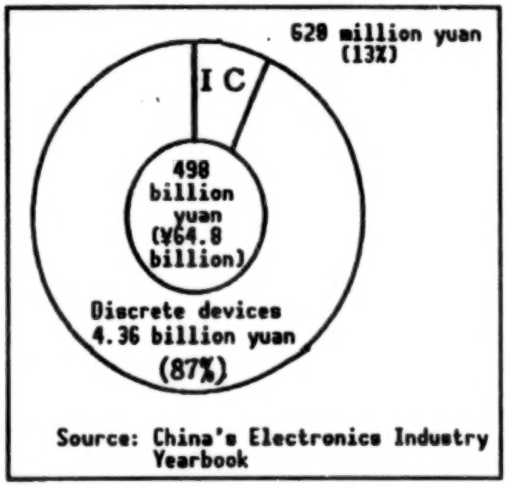

Figure 5.1.2.3 Semiconductor Production in China (1992)

As of 1993, China's principal state-run semiconductor makers possessed the technology to mass produce wafers in the range of 3 to 5 inches, and to process feature sizes ranging from 2 to 5 microns. As downscaling progresses in future, under the guidance of foreign-capital manufacturers, China's goal is to achieve submicron-level geometries by 1995.

5.2 China's Semiconductor Investment Climate

5.2.1 Semiconductor Industry Policies

(1) Eighth Five-Year Plan (1991-95)

In order to achieve the following goals, the Chinese government has designated the semiconductor industry a national priority business, and has set forth in its Eighth Five-Year Plan specific goals to be achieved in this industry by 1995.

1) We will actively introduce electronics technology applications from foreign countries into each of our industries, and then strive to improve domestic production ratios and promote the development of the electronics industry by assimilating and absorbing the technologies thus introduced.

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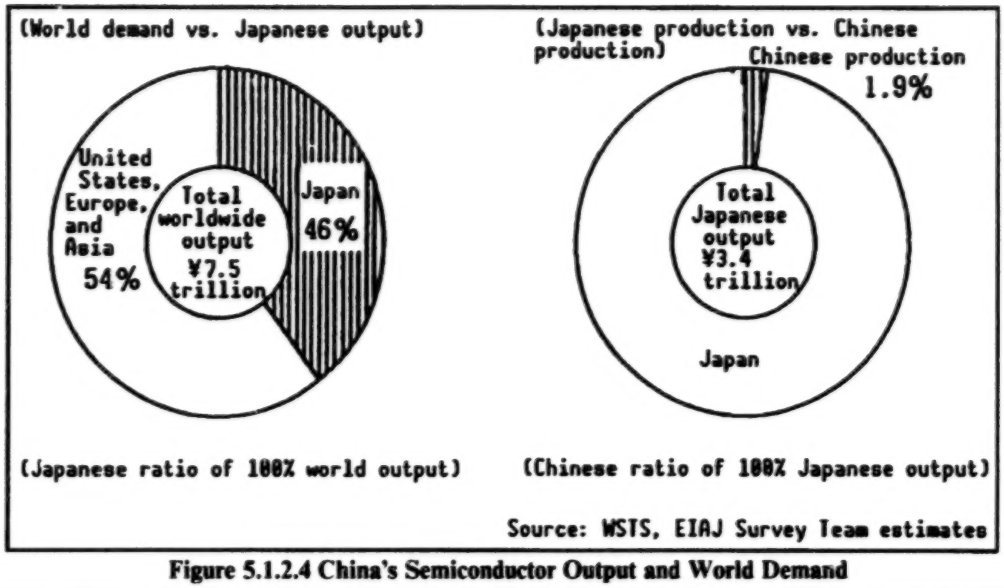

Figure 5.1.2.4 China's Semiconductor Output and World Demand

2) We will stress the development of ICs and computers, and will energetically develop microelectronics, computer and telecommunications technologies and equipment.

(Specific Semiconductor Industry Goals for 1995 Stipulated in the Eighth Five-Year Plan)

1. IC-related Goals:

   A) IC production capabilities (by value): Roughly 5 billion yuan.

   B) IC production capabilities (by quantity): 800 million devices.

   Domestic demand for products fabricated using 5-micron technology will be satisfied domestically. Fifty percent of domestic demand for products fabricated using 2- or 3-micron technologies will be met by commercializing these capabilities domestically. Small-lot production capabilities will be developed for products manufactured using 1- to 1.5-micron technologies.

2. Discrete Device-related Goals:

   A) Transistor production capabilities: 10 billion devices.

   B) Optoelectronics device production capabilities: 150 million devices.

   C) Sensor production capabilities: 100 million devices.

3. The following firms will play a central role in promoting on a priority basis the establishment of microprocessing technologies and volume production systems.

   A) China Huajing Electronics Group (State-run)

   B) Huayue Microelectronics Co., Ltd. (State-run)

   C) Shanghai Beiling Microelectronics Manufacturing Co., Ltd. (Foreign capital firm)

   D) Shanghai Philips Electronics Company (Foreign capital firm)

   E) Shougang-NEC Electronics Company (Foreign capital firm)

(2) Policies Aimed at Improving Investments in Semiconductors

The following preferential treatment measures are being applied to "Product Exporting Companies" and "Advanced Technology Companies" as currently set forth in the "Provisions Regarding Ministry of State Incentives to Foreign Investment" (issued October 1986).

1. Definitions of "Product Exporting Companies" and "Advanced Technology Companies."

   A) "Product Exporting Companies"

      1) Companies that produce export goods;

      2) Whose ratio of exports exceeds 50%; and

      3) Whose foreign currency holdings either balance out or are in the black

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B) "Advanced Technology Companies"

1) Companies whose technologies are investment incentive items, and possess advanced capabilities and applicability;

2) Whose technologies are in short supply domestically, or related to the development of new products and models; and

3) Whose technologies will expand exports or substitute for imports.

2. Specific Preferential Treatment Measures

1) Partial exemption from repaying subsidies to the State.

With the exception of payments or reserves toward workers' insurance, welfare costs and housing subsidies, the Chinese government will exempt preferred companies from repaying various worker-related subsidies;

2) Reduced land utilization charges.
Instead of the usual 5-300 yuan/m^2 per year leasing charges, those companies that make lump sum payments of 5-20 yuan/m^2 per year (development fees) or that develop the land themselves, will only be required to pay 3 yuan/m^2 per year to lease land, provided that land is not located in the business section of a large city. Certain regional governments have put together preferential treatment packages that include fixed-period exemptions from paying leasing charges or half-price leasing charges for fixed periods of time.

3) Priority supplies of water, electricity, transportation and communications.

4) Granting of loans on a priority basis.

5) Exemption from paying taxes on profits transferred to foreign countries.

6) Reduced corporate income taxes and combined industrial-commercial taxes.

For product exporting companies, those companies with export ratios of 70% or over will only have to pay half the required corporate income taxes even after the corporate income tax reduction/exemption period has expired (after their sixth year of operation inside China) (10% for those companies who previously had their income taxes reduced/exempted up to 15%). Advanced technology companies will also have the period during which they receive a reduction of or exemption from paying income taxes extended an additional three years (from the sixth to the eighth year of their operation). Also, combined industrial-commercial taxes levied on export products will be abolished beginning January 1994.

7) Refund of taxes on re-investments made inside China.

In addition to the above-cited preferential treatment measures, "Product Export Companies" and "Advanced Technology Companies" in the semiconductor industry also receive income tax reductions/exemptions from the individual cities where they locate their operations, i.e., the 14 free trade cities inside the special economic zones. This amounts to dual preferential treatment.

Recent movements include the preparation and submission to the State Council by that Ministry's State Planning Commission of a draft bill titled "Provisional Regulations on Guidelines for Foreign Corporate Investment," and the "1993-95 List of Industries Open to Foreign Corporate Investment and Related Guidelines," which are expected to be put into effect in the near future. These regulations/guidelines divide Chinese projects into four categories vis-a-vis foreign corporate investors: "Investment Encouraged," "Permission Required," "Restricted" and "Prohibited." Those projects categorized as "Investment Encouraged" are being strongly promoted by the Chinese government through the granting of preferential treatment to investors. The electronics industry has 15 projects that are "Investment Encouraged," three of which fall into the semiconductor realm. These include upstream IC manufacturing processes, advanced technology aspects of discrete device fabrication, and those facets of downstream processes (assembly) that China is still not able to manage all on its own, i.e., packaging technology.

China has been reviewing these four investment categories since the beginning of this year, and plans to make preferential treatment available for investments in fields whose products are deemed marketable inside China, and in areas where China does not possess production technology. Conversely, China will not permit foreign-capital production operations in those fields where there are already an overabundance of production capabilities.

Semiconductor fields that fall into the "Investment Encouraged" category include:

1. LSI production;

2. New electronics devices and power devices; and

3. The manufacture of optoelectronics devices (laser diodes, charge-coupled devices, etc.), piezoelectric devices and sensors.

In addition to the preferential treatment regulations currently in effect for these "Investment Encouraged" areas, China will also provide preferential treatment

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measures in accordance with the business term, location rate, scope of business, product export ratio, and ratio of registered capital to total investment.

Semiconductor products outside of those cited above fall into the investment category of "Permission Required." Details concerning preferential treatment for investments in this category are ambiguous, but will probably be on a par with regulations currently in effect.

5.2.2 China's Semiconductor Infrastructure

(1) Electric Power

Electric power required for the production of semiconductors differs for upstream and downstream processes, but basically speaking, a certain fixed amount of electricity must be supplied in an uninterrupted manner and at a stable voltage. Part of the preferential treatment for foreign-capital semiconductor plants is priority supplies of electric power. However, problems arise from that fact that there just isn't enough publicly-generated electric power to begin with, which is especially disconcerting as far as upstream processes are concerned. Semiconductor plants must therefore generate their own power.

(2) Semiconductor Engineers

The development and manufacture of semiconductor devices requires engineers with specialized knowledge.

Beijing, Qinghua, Chengdu and Shanghai Jiaotong Universities are among those Chinese institutions of higher learning turning out these kinds of engineers. The electronics departments at these schools are all very popular among the student population, and attract high-quality students. Graduates find employment at China's design centers and other domestic semiconductor-related enterprises. Outstanding graduates either remain on at their schools' research labs and continue doing research, or make their way to Silicon Valley in the United States. The latent potential for Chinese electronics engineers is high; they are by no means inferior to electronics engineers being turned out in other countries around the world.

(3) Peripheral Industries

There are enterprises in China that manufacture the equipment, facilities and raw materials used in the production of semiconductors, but they are all small-scale operations, and their quality criteria are not up to Japanese standards, making it difficult to utilize their products. Therefore, once a company establishes operations inside China, it finds itself compelled to import these products from Japan and other foreign suppliers, and in most cases finds itself spending more time and money on this aspect of its operations than it otherwise would. In its interviews with foreign-capital semiconductor firms in China, the Survey Team learned that almost 100% of all manufacturing equipment and materials, such as packages, lead frames and gold wiring are being imported from overseas, and that most companies interviewed expected this trend to continue relatively unchanged in future. These same firms are considering procuring certain special gases and chemicals from foreign-capital manufacturers with operations in China (or who are planning to expand into China in future).

(4) Others

Those points that a company must pay particular attention to when considering setting up operations inside China (especially in the case of joint venture operations) include basic differences in thinking that arise from language problems and differing systems, as well as basic differences in construction concepts (types of materials used and what is meant by a "finished" structure).

5.2.3 Trends in the Management of Semiconductor-related Exports

(1) Restructuring of COCOM

The COCOM regulation were enacted to control exports of military-oriented strategic technologies and materials from the West to communist bloc nations. However, in line with the relaxing of East-West tensions beginning in the late 1980s, COCOM regulations have also been relaxed. As shown in Table 5.2.3.1, even those COCOM regulations applicable to semiconductors have been significantly relaxed during the past few years. In 1994, the COCOM system itself is expected to be dissolved, and will most likely be replaced by a new agency. As yet, nothing is known in details about the new regulations that will be implemented at that time, but they are expected to be revisions of COCOM regulation in effect during 1993.

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Table 5.2.3.1 Trends in Major COCOM-Regulated Semiconductor Products and Applications

Product	Pertinent criteria		
	November 1990	November 1991	December 1993
DRAM	Memory capacity 1Mbit maximum 256K < memory ≦ 1Mbit up to 80ns	Basically, not applicable	Same as at left
SRAM	Memory capacity 256Kbit maximum 64Kbit < memory ≦ 256Kbit up to 80ns	Memory capacity 1Mbit maximum 256Kbit < memory ≦ 1Mbit up to 25ns	Memory capacity 4Mbit maximum 1M bit < memory ≦ 4Mbit up to 20ns
EPROM	Memory capacity 256Kbit maximum	Basically, not applicable	Same as at left
Microcomputers/microprocessors	External data bus width 16bit maximum Maximum clock frequency 20MHz	External data bus width 32bit maximum maximum clock frequency 40MHz	Same as at left
Standard Logic	Gate propagation delay time < 1ns No. of terminals > 128	Basically, not applicable	Same as at left
Computers	Data processing speed 275Mbit/sec maximum	Compound theoretical performance 12.5MTOPS maximum (equivalent to data processing speeds of up to 400 Mbit/sec) Excludes PCs up to 80486 (33MHz) level	Compound theoretical performance 67MTOPS maximum excludes PCs up to pentium level
HDD	Maximum transmission speed 10.3Mbits/sec	Maximum transmission speed 25Mbit/sec	Maximum transmission speed 47Mbit/sec

* Applicable: products regulated under the Foreign Exchange and Foreign Trade Control Act.

* Not applicable: Products not regulated under the Foreign Exchange and Foreign Trade Control Act.

Source: EIAJ Survey Team

(2) Nonproliferation Regulations

Nonproliferation regulations is a generic term for export regulations enacted for the purpose of preventing the proliferation of materials and technologies linked to the development and manufacture of weapons of mass destruction (nuclear weapons, chemical and biological weapons, and missiles). These regulations are broadly divided into two types. The first type covers those materials and technologies that are listed up and controlled on the basis of various international agreements (regimes). Participating countries have formulated ordinances for this purpose, and even Japan has already incorporated these regulations into its export ordinances. The second type of nonproliferation regulations are those enacted by the United States, the United Kingdom and Germany on their own accord, and which are designed to control the export of those materials and technologies that are not necessarily technologically advanced, but which the exporting country knows are linked to weapons of mass destruction for use by a country or countries currently engaged in or on the brink of conflict. This second type of nonproliferation regulations are called "catch-all regulations" because they are not limited to those products that have been targeted and listed up. They are also referred to as "known regulations" because the products controlled are those known by the exporter. At present, work is proceeding ahead in Japan as well to create legislation for the same purpose, and we can expect to see these rules incorporated into a new framework for controlling exports in the near future.

5.2.4 Process and Procedures for Entering the Chinese Semiconductor Industry

(1) Chinese Government Agencies Charged With Managing the Influx of Foreign Capital

Figure 5.2.4.1 provides a line and block chart of those Chinese government agencies in charge of administering the influx of foreign capital.

The Ministry of Foreign Trade and Economic Cooperation is the agency charged with drafting laws concerning the introduction of foreign capital into the semiconductor industry, serving as China's window for receiving foreign capital and examining all projects that exceed a fixed scale. This fixed scale or scope refers to all projects in excess of US$30 million for the coastal regions, and exceeding US$10 million for interior areas; projects smaller in scale than these are not handled by the Central Government's Department of Foreign Trade and Economic Cooperation, but rather, are entrusted to the

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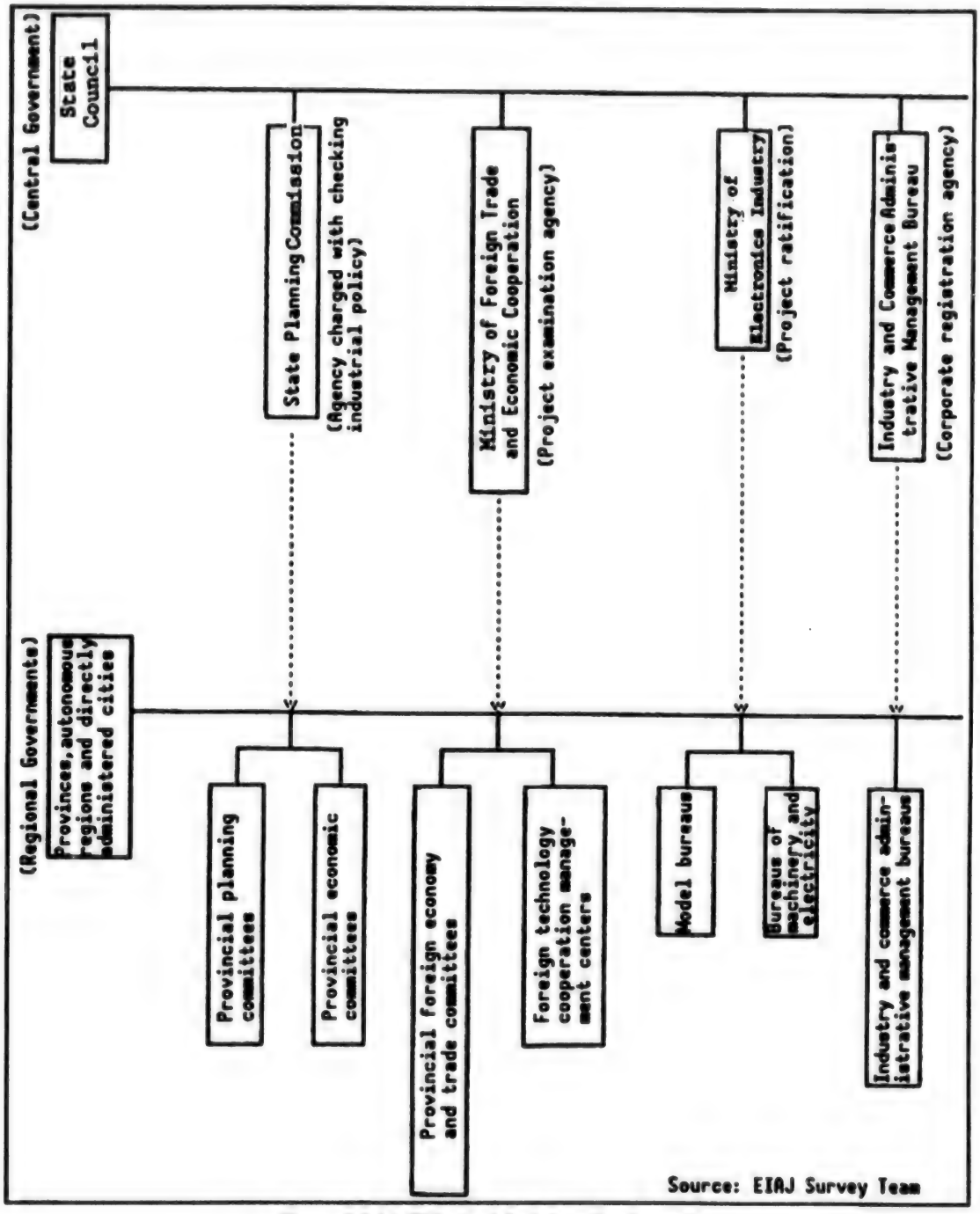

Figure 5.2.4.1 China's Administrative Agencies

respective regional governments. However, these regional governments are required to submit paperwork outlining the contents of such projects to the Foreign Investment Management Office of the Ministry of Foreign Trade and Economic Cooperation a few days after decisions to undertake a project are made.

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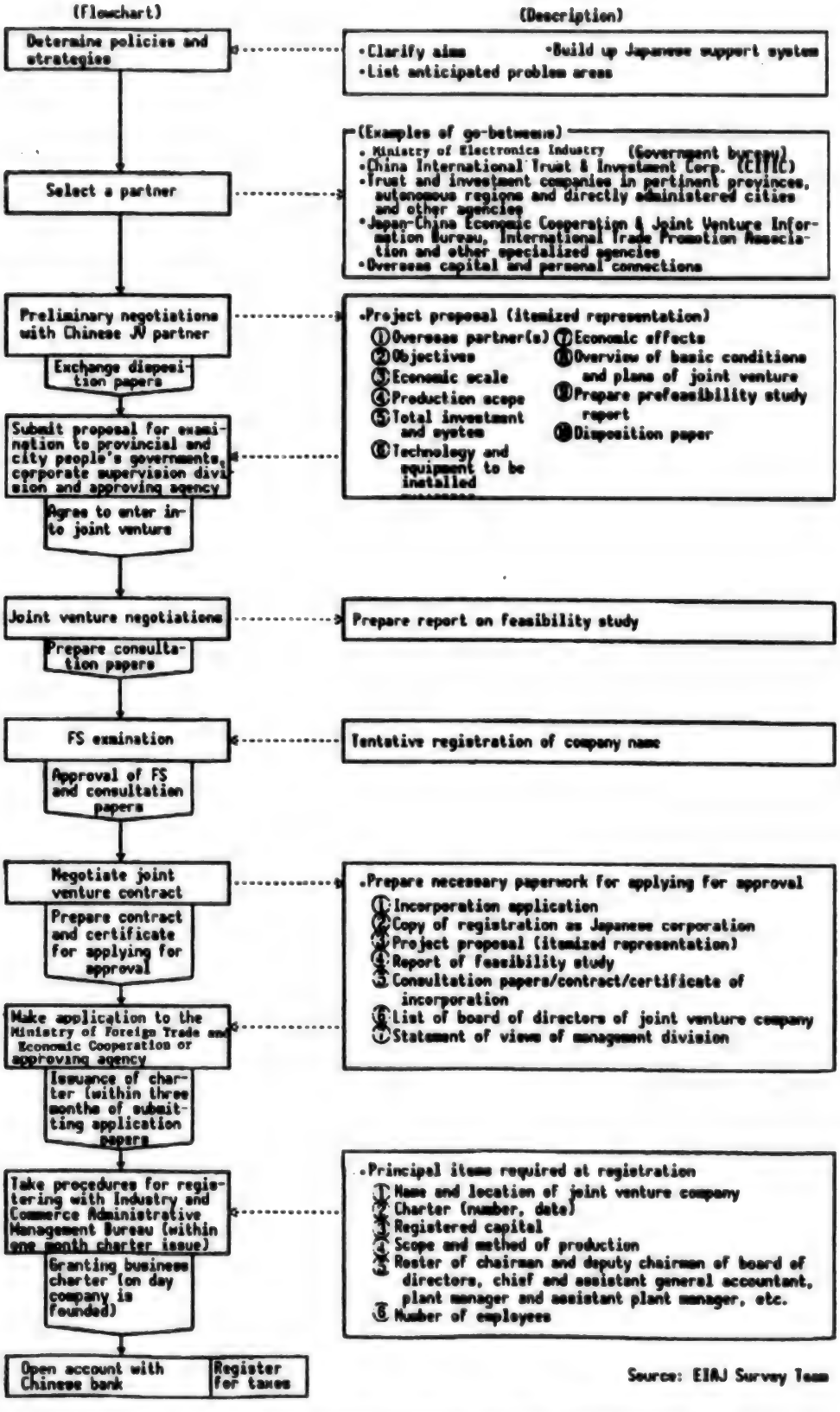

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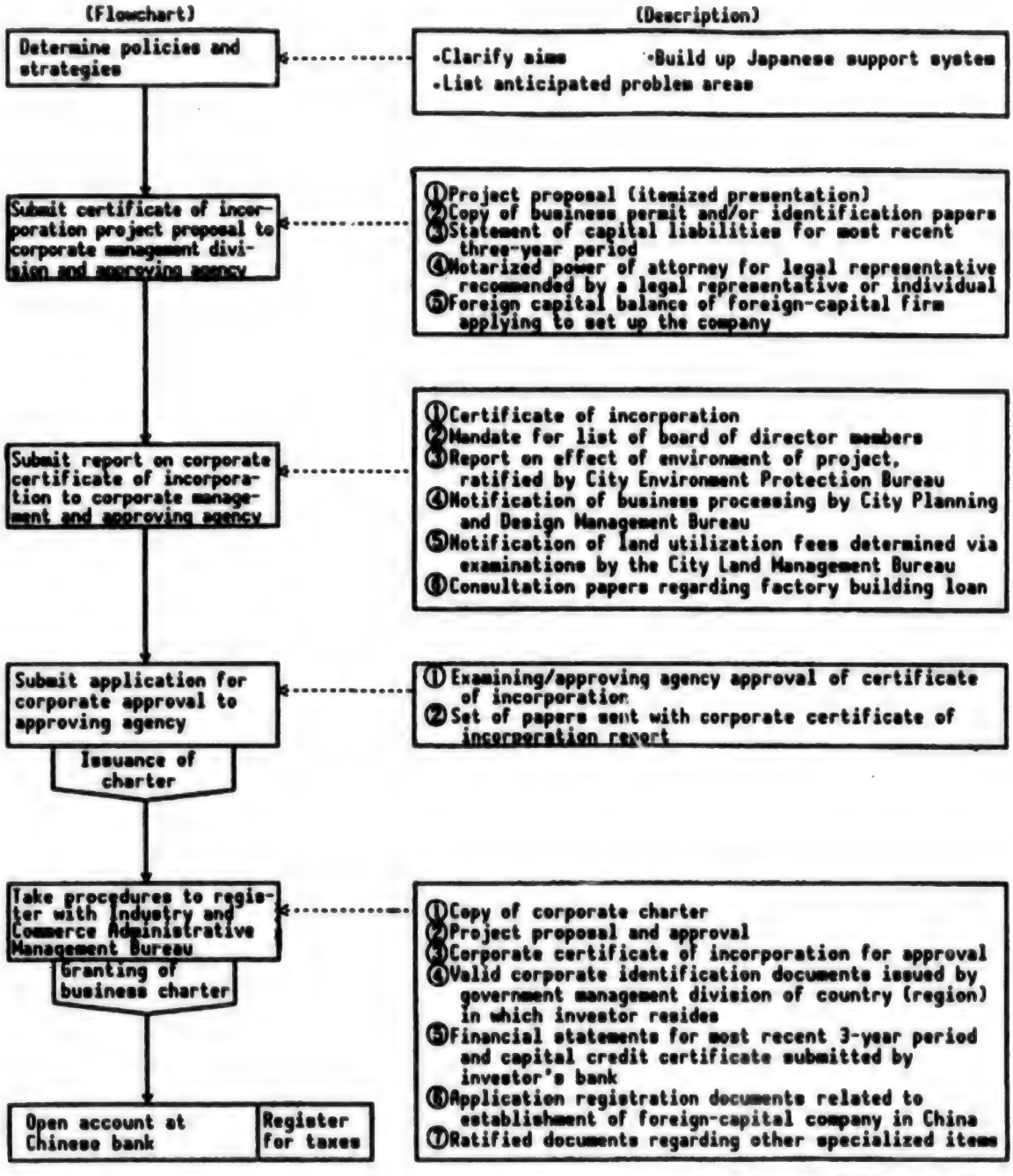

Source: EIAJ Survey Team

(2) Specific Procedures

1)Concrete Procedures for Entering Into a Joint Venture

2) Concrete Procedures for Establishing a Wholly-owned Company

5.3 Trends in China's Semiconductor Market

5.3.1 Overview of the Semiconductor Market

Public statistics on the semiconductor market in China are lacking, but estimates made by the Survey Team as shown in Table 5.3.1.1 indicate a market worth roughly

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7.9 billion yuan in 1992. This worked out to about ¥ 102.7 billion calculated at one yuan = ¥ 13. Bolstered by favorable production of electronics equipment, the Chinese semiconductor market is expected to reach 9.9 billion yuan (¥ 128.7 billion) in 1993, and then grow to a 15.1 billion yuan (¥ 196.3 billion) market by 1995. As shown in Table 5.3.1.2, China is expected to account for 2% of the world's overall semiconductor market in 1995. Thus, although China's semiconductor market is small, as shown in Table 5.3.1.4, it is exhibiting a high rate of growth compared to markets in other regions of the world. China is expected to play a key role as a world-class electronics equipment manufacturer, and it is seen as growing to become a huge market for semiconductors in future.

Table 5.3.1.1 Growth of China's Semiconductor Market

	1991	1992	1993	1994	1995	Average annual growth rate 1991-95
In yuan (100 millions)	63	79	99	123	151	24.4%
Growth over previous year (%)	—	25.4	25.3	24.2	22.8	—
In yen (100 millions)	819	1,027	1,287	1,599	1,963	—
Yen-yuan rate	13	13	13	13	13	-

Source: EIAJ Survey Team estimates

Table 5.3.1.2 Growth of Semiconductor Market by Region (Units: ¥ 100 million/%)

		1991	1992	1993	1994	1995
Size of market	China	819	1,027	1,287	1,599	1,963
	Asian NIES/ ASEAN/Others	10,144	12,419	14,589	16,149	17,385
	Asian/Pacific	10,963	13,446	15,796	17,748	19,348
	Japan	28,053	24,633	26,099	28,137	29,744
	North America	20,604	23,382	27,231	29,599	30,432
	Europe	13,554	14,567	15,908	16,752	17,585
	World market	73,174	76,029	85,034	92,236	97,109
Market composition	China	1.1	1.4	1.4	1.7	2.0
	Asian NIES/ ASEAN/Others	13.9	16.3	17.2	17.5	17.9
	Asia/Pacific	15.0	17.7	18.6	19.2	19.9
	Japan	38.3	32.4	30.7	30.5	30.6
	North America	28.2	30.8	32.0	32.1	31.3
	Europe	18.5	19.2	18.7	18.2	18.1
	World market	100.0	100.0	100.0	100.0	100.0
Yen/US$ exchange rate:		134	127	110	105	105

Source: EIAJ Survey Team estimates based on WSTS

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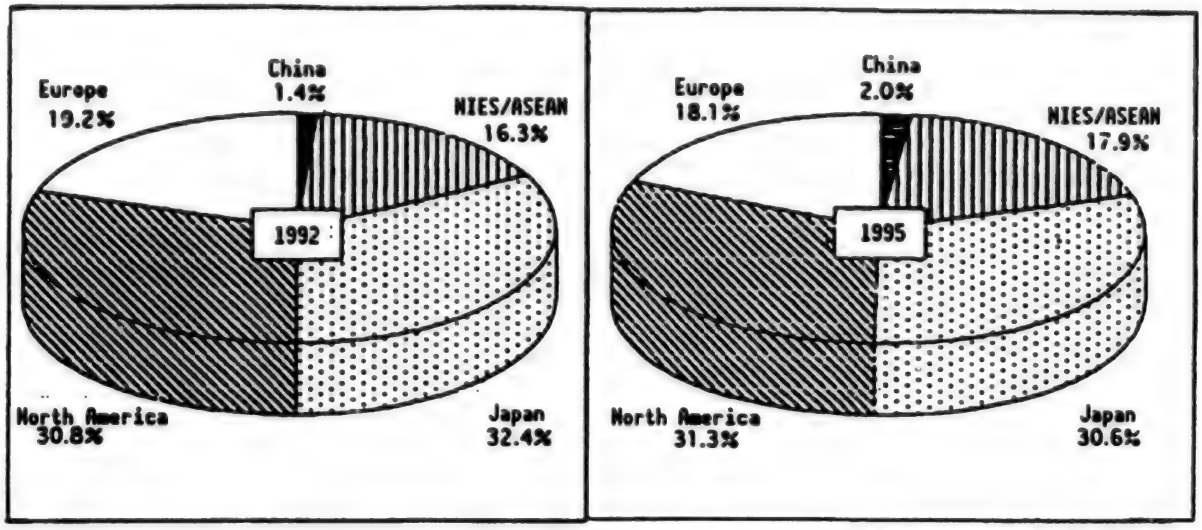

Source: EIAJ Survey Team

Figure 5.3.1.3 Transition in Composition of World Semiconductor Market by Region (1992/1995)

Table 5.3.1.4 Rate of Growth of Semiconductor Market by Region (Based on indigenous currencies)

	1991	1992	1993	1994	1995	Average annual growth rate 1991-95
China (Yuan)	—	25.4	25.3	24.2	22.8	24.4
Asia/Pacific (US$)	18.4	29.4	35.6	17.7	9.0	22.5
Japan (Yen)	-0.9	-12.7	5.9	8.4	5.7	1.5
North America (US$)	6.4	19.7	34.5	13.9	2.8	17.2
Europe (ECU)	8.1	8.6	38.6	12.1	5.0	15.4
World Market (US$)	8.1	9.6	29.1	13.6	5.3	14.1

Source: EIAJ Survey Team estimates based on WSTS

In 1992, major demand for semiconductors in China, as shown in Figure 5.3.1.5, centered around the fields of television, audio (primarily radio/cassette players) and other consumer-oriented electronics equipment (73% of total demand), of which semiconductors for use in color televisions (33%) and audio equipment (20%) accounted for 53% of overall demand.

Also, demand for semiconductors for use in communications equipment (switching equipment, telephones, portable telephones and pagers), personal computers and terminal equipment (monitors) is exhibiting rapid growth today in line with the building up of information and communication infrastructures inside China and the resultant increased production of these products. Demand for semiconductors for use in these types of industrial equipment is expected to reach ¥ 70.6 billion (36% of total demand) by 1995. The production of semiconductors for use in videotape recorders (VTRs) is expected to take off in earnest in 1994 and after, and demand for these devices is seen as reaching 8% (¥ 15.7 billion) of total demand by 1995.

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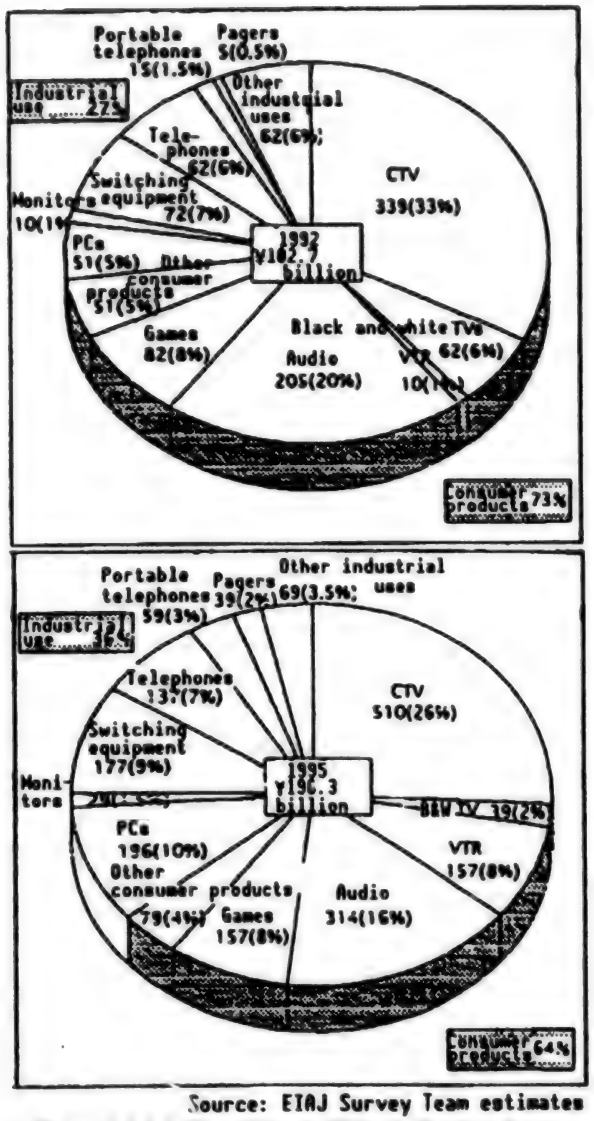

Source: EIAJ Survey Team estimates

Figure 5.3.1.5 Transition in China's Semiconductor Market by Application (1992/95)

From the standpoint of future supplies of semiconductors, the Chinese government is already maneuvering to become a member of the GATT in 1994, so we will probably begin to see huge imports of high-performance, high-quality, low-cost foreign-made semiconductors into China in future as customs duties are lowered. When this happens, Chinese-made semiconductors, which are not competitive on the international market, will clearly receive a big setback. And China's electronics equipment makers will find themselves in a situation where they will have to use foreign-produced semiconductors in order to produce high-quality, multifunctional equipment. The supply side of the coin, then, is expected to place China's semiconductor manufacturers in a real tight spot.

* Notes

- Method Used to Calculate Semiconductor Demand

The Survey Team arrived at the figures used in computing semiconductor demand by type of equipment by multiplying electronic equipment output on a value basis (production output (by type of equipment) x average unit cost) by the semiconductor input coefficient.

- Semiconductor Demand in China

In China, semiconductors can be divided into those procured inside China (Chinese- and foreign-made devices) and those imported as kits for knockdown (KD) production. In order to use the above-described calculation method, the Survey Team used the total of both domestically-procured and imported semiconductors to arrive at the semiconductor demand in China. The Survey Team estimated the ratio of domestically-procured semiconductors to imported kits to be 50%.

5.3.2 Overview of Market for Discrete Devices

Figure 5.3.2.1 illustrates the transition of the market for discrete devices in China.

China's market for discrete devices (diodes, transistors, light-emitting diodes (LEDs)) currently centers around audio-visual equipment such as television sets, radio/cassette players, and et cetera. In the future as well, as pointed out in Figure 5.3.2.1, bolstered by steady production of consumer products and favorable exports of mostly low-cost devices (primarily diodes), production of discrete devices is expected to rise from 5.7 billion units in 1992 to 7.6 billion units in 1995, with domestic demand also exhibiting steady growth, increasing from 5.6 billion units in 1992 to 6.7 billion units in 1995.

However, in line with the higher-level functions currently required of electronics equipment, China will be forced to rely on imports of high-quality ultrahigh-frequency devices and high-pressure, heavy-current transistors for some time to come. This means that exports of discrete devices will continue to center around inexpensive products, while imports of these devices will focus primarily on high-value-added devices.

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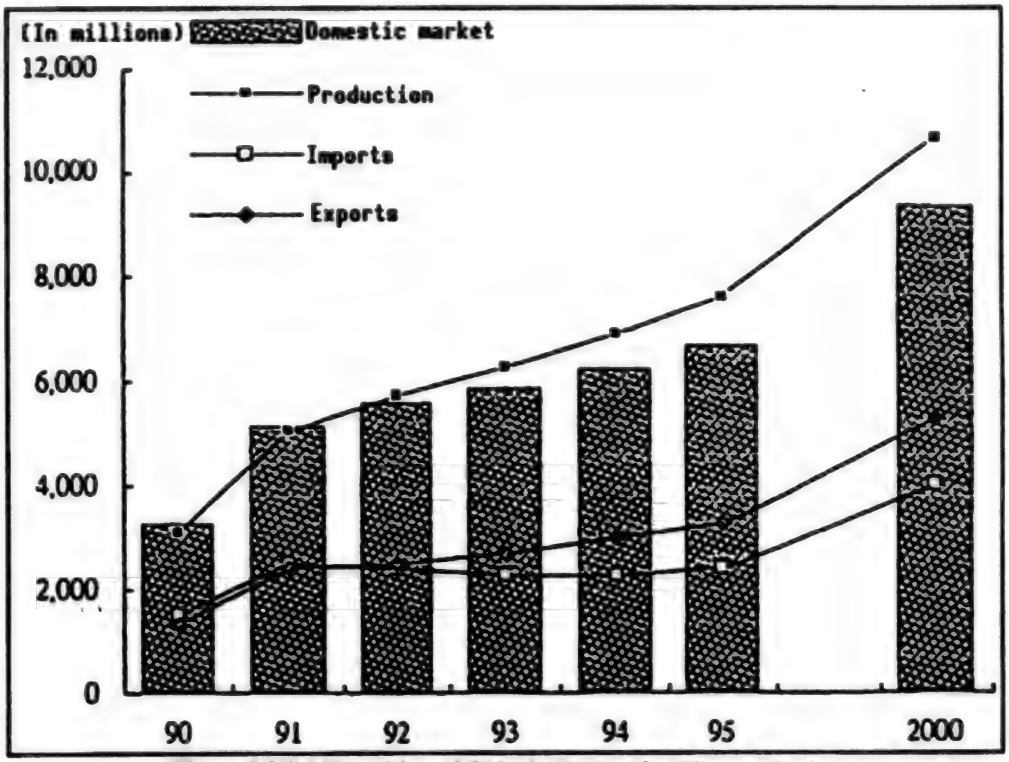

Figure 5.3.2.1 Transition of China's Market for Discrete Devices

China's Market for Discrete Devices (Unit: In millions, %

	1990	1991	1992	1993	1994	1995	2000
Production	3,110	5,060	5,710	6,280	6,910	7,600	10,600
(Growth over previous year)	29.6	62.7	12.8	10.0	10.0	10.0	(7.0)
Imports	1,500	2,500	2,400	2,300	2,300	2,400	4,000
(Growth over previous year)	50.0	66.7	-4.0	-4.2	0.0	4.3	(10.8)
Exports	1,311	2,418	2,500	2,700	3,000	3,300	5,300
(Growth over previous year)	117.8	84.4	3.4	8.0	11.1	10.0	(9.9)
Domestic market	3,299	5,142	5,610	5,880	6,210	6,700	9,360
(Growth over previous year)	43.6	55.9	9.1	4.8	5.6	7.9	(6.9)

Note 1: Domestic market = production + imports - exports

Note 2: Import figures based on EIAJ Survey Team estimates

Note 3: Figures in ( ) in 2000 column reflect average annual growth rate for period 1995-2000.

Sources: 1990-92 = China Statistics Yearbook; 1993-2000 = EIAJ Survey Team estimates

5.3.3 Overview of China's IC Market

Figure and Table 5.3.3.1 show the transition of China's IC market. As discussed earlier, the Chinese government estimates that IC production will reach 600 million units in 1995, but when the infrastructure (electric power, water, etc.) and production facilities are taken into consideration, this goal would appear to be fairly difficult to meet. The Survey Team estimated 1995 IC output in China to reach around 350 million units. However, the IC market in China is expected to reach 1.2 billion units in 1995 and 3.2 billion units in 2000 (an average annual growth rate between 1995-2000 of 21.7%) in response to the rapid growth in production envisaged in future for VTRs, communications equipment and PCs.

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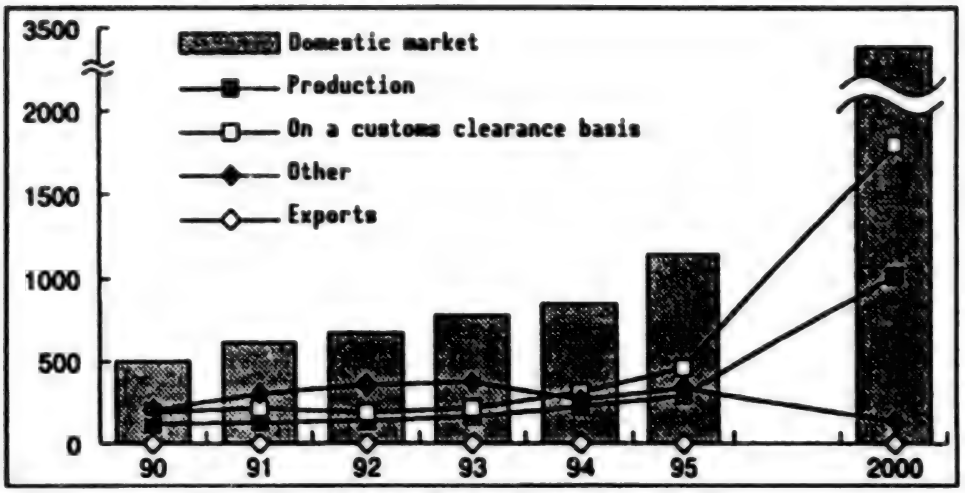

Figure 5.3.3.1 Transition of China's IC Market

Table 5.3.3.1 Transition of China's IC Market (Unit: In millions/%)

	1990	1991	1992	1993	1994	1995	2000
Production (Growth over previous year)	97 1.0	128 32.0	143 11.7	170 18.9	250 47.1	350 40.0	1,100 (25.7)
Imports—On customs clearance basis (Growth over previous year)	188 60.7	249 32.4	188 -24.5	250 33.0	350 40.0	480 37.1	1,950 (32.3)
Imports—Other (Growth over previous year)	218 21.1	270 23.9	379 40.4	392 3.4	310 -20.9	390 25.8	200 (-12.5)
Exports (Growth over previous year)	8 -11.1	9 12.5	10 11.1	12 20.0	15 25.0	20 33.3	50 (20.1)
Domestic market (Growth over previous year)	495 39.8	638 28.9	700 9.7	800 14.3	895 11.9	1,200 34.1	3,200 (21.7)

Note 1: Domestic market = production + imports - exports.

Note 2: Figures in ( ) in 2000 column reflect average annual growth rate for period 1995-2000.

Sources: 1990-92 = China's Statistics Yearbook; 1993-2000 = EIAJ Survey Team estimates

According to Chinese government sources, in 1992, total IC demand was 700 million units, and in 1994, it is expected to reach 900 million units, but "Domestic production of ICs in 1993 probably worked out to 170 million units." In other words, if we assume that total IC demand in 1993 was 800 million units, then 80% of that total demand was met by foreign-made ICs. We will discuss this point again later in this report, but the numerous problems plaguing China's IC industry, i.e., the obsolescence of production equipment, immature peripheral industries, and a dearth of foreign currency, will make it very difficult to bridge the supply-demand gap. China's government realizes the limitations of the strong domestic IC production policy it has implemented, and seems to believe that the only way of dealing with this problem is to enter into joint ventures with foreign firms to strengthen productivity and prevent smuggling. The government would therefore like to get the joint venture businesses it is currently promoting off the ground by the time the Eighth Five-Year Plan ends in 1995, and thereby meet at least 50% of its total IC demand with domestically-produced ICs.

5.3.4 Demand Trends by Application

(1) Televisions

In the past, semiconductors for use in Chinese televisions had to be approved by the government (Ministry of Electronics Industry) before they could be marketed inside China. It was a real case of first come-first served, with only those foreign firms that had been recognized as having contributed to the development of China's electronics industry being granted priority selling rights. However, in sync with the acceleration of current reform and open door policies, China is recognizing the originality of each manufacturer's products (the Electronics Industry Department has changed its guidelines and

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instructions), making it possible for Chinese television manufacturers to select semiconductors on their own.

Because of the high import taxes (Footnote) (The Combined Industry and Commerce Tax has apparently been discontinued, and in addition to conventional import duties (21%) a new tax was introduced in January 1994 (Increased value tax: 17%).) being levied on imported ICs for use in color televisions, Chinese-made (upstream processing done in Japan; downstream processing done in China) ICs are being used for the most part, but for high-end models equipped with remote control devices and signal processors, Chinese makers have no choice but to rely on ICs imported from Japan and Europe. Remote controllers are becoming standard equipment on the most popular models (14-inch through 25-inch), and the number of ICs used per standard TV set is relatively high, bringing Chinese TVs more or less on a par with those made in Japan.

Most signal processing systems currently feature a two-chip configuration (made by Huajing Electronics), but a one-chip signal processor will be needed to improve reliability and to achieve reduced power consumption. Foreign firms are expected to initiate a sales offensive in future, rapidly advancing one-chip configurations until they account for roughly 60% of all signal processing systems used in Chinese TVs. Also, China uses the phase-alternation line (PAL) system for broadcasting color TV signals, but receivers are in the process of changing from the PAL system to a PAL/NTSC switched (multisystem) system.

Large state-run color TV makers have already equipped their sets with multiple functions (capable of handling BS, karaoke, and PAL/NTSC/SECAM, and equipped with picture-in-picture (PIP) and surround sound functions) and have developed large-screen TVs (29-inches and larger), and the high functionality of color TV ICs is advancing.

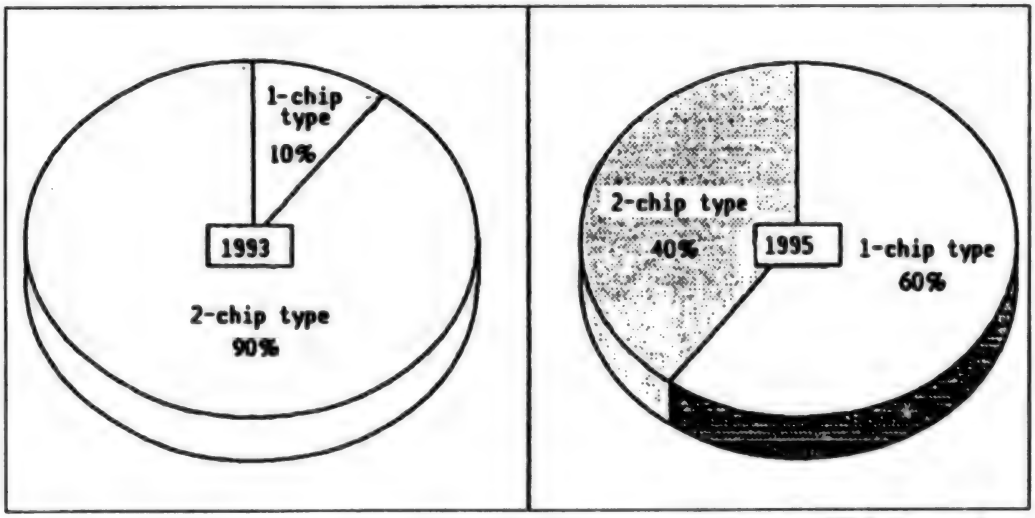
(2) VTRs

The production of VTRs in China is expected to take off in earnest in and after 1994 with the help of foreign capital. A Chinese enterprise signed a joint venture deal with a Japanese firm at the end of 1993 to establish a company for manufacturing key components of VHS-format VTRs, and this venture is moving to produce an integrated chassis in China.

For the time being, China will have to rely on imports from Japan for key ICs used in VTRs, such as those for the tuners, VIF, sound intermediate frequency (SIF), audio/video switches, video signal processors, and record/playback head amplifiers, as well as the microcomputers for the syscon/server, display and remote control device. But supplies of domestically-produced parts will be essential for the priority production of VTRs scheduled to be done by 10 state-run plants. We can expect to see a rapid expansion of domestically-produced VTR ICs with help from foreign capital. Demand for the discrete devices used in VTRs, such as power metal-oxide semiconductor field-effect transistors (MOSFETs), switching power transistors and high frequency tuner transistors, is also expected to increase. And although it will be gradual, it is felt that the ratio of discrete devices procured domestically will go up, especially for bipolar transistors.

(3) Radio/Cassette Players and General Audio Equipment

In the area of semiconductors for use in radio/cassette players and general audio equipment, Hong Kong, as



Source: EIAJ Survey Team

Figure 5.3.4.1 Projected Market for One-Chip Signal Processors for Chinese Color TVs

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well as Taiwanese and Japanese joint ventures in particular are shifting their manufacturing operations to China, where production of equipment capable of running compact discs (CDs) is rapidly increasing. For China, this is the field that promises to earn it the most foreign currency, and, in future, to turn it into a world-class production base for popular audio equipment. China is producing radios equipped with CD drives by importing primarily Japanese-made kits (pickup + analog signal processor (ASP), digital signal processor (DSP), digital-to-analog converter (DAC), central processing unit (CPU) and driver) via Hong Kong. Radio/CD players have become China's main export product (to the United States, Europe and Japan) in this category, and demand for semiconductors for these products is expected to increase amidst the move toward higher functionality.

(4) Air Conditioners

In 1992, 1.52 million air conditioners were manufactured in China, but demand for these machines was estimated at 2 million units that year. In future, the market for window air conditioners in particular is expected to expand in the cities, and demand for 1995 is seen as reaching 3.5 million units. Because full-scale production will begin at foreign capital (especially Japanese) joint venture factories in the coastal regions in the future, we can look forward to rising demand for microcomputers for controllers, power transistors and modules for inverters, plus MOSFETs, hybrid ICs and other semiconductor devices.

(5) Personal Computers

The microprocessing units (MPUs) used by China's principal personal computer (PC) manufacturers (Great Wall and Changjiang) are Intel microprocessors, and have evolved from the 8088, 86 and 286 to the 386, which is the principal MPU currently being installed in Chinese PCs. But production of PCs equipped with 486 chips has already commenced.

According to the people the Survey Team talked with at Changjiang Computer, their PCs are IBM-compatible equipped with Intel's 386 microprocessor, and come with 1-4 megabytes of internal memory (primarily Japanese) and 40-megabyte hard disks as standard equipment.

In line with the building up of the information and communications infrastructures in future, demand for PCs, especially for business use, is expected to expand rapidly, and U.S. and European PC manufacturers are lining up to enter the Chinese market in anticipation of this happening (IBM has already decided to start producing PCs in China during 1994). In the mid- to long-term, China is expected to become a huge consumer of MPUs (mostly Intel), memory and logic devices, but as things stand now, due to a dearth of foreign currency, procurement of semiconductors is extremely difficult, a fact that is putting a strain on all of China's PC manufacturers. Full-scale production of Chinese PCs will have to wait until domestic production of memory and other semiconductor devices gets off the ground.

(6) Portable Telephones

Based on the fact that China's domestic telephone network is still in the process of being constructed (as of 1993, only 2.2% of the population had telephones) and the increased demand for communications capabilities in the cities, demand for portable telephones in China is expected to grow rapidly in future. At present, Motorola, Ericcson [phonetic], Nokia and other U.S. and European makers have a large share of the portable telephone market in China, but Japanese-affiliated firms have also captured a portion of the market and are developing their production capabilities with the export market in mind. New entrants to the market and the realization of full-scale production capabilities expected in 1994, should lead to keen competition between the U.S., European and Japanese manufacturers.

As for semiconductor demand, since production will initially be on a semi-knockdown (SKD) or complete knockdown (CKD) basis, portable telephone manufacturers operating inside China will have no choice but to import their ultrahigh frequency devices, phase-locked loop (PLL) synthesizers, controllers, voice processors and other key semiconductor devices from overseas. But we can expect to see these semiconductor products manufactured domestically over the mid to long term.

(7) Pagers

As pointed out above, China's telephone network is still in its infancy, and the shortage of telephone circuits has kept the number of public telephones extremely low. As a result, pagers have become extremely popular in the cities as a means of transmitting information. Roughly 50% of all young adult males (including university students) in Beijing, Shanghai and other major metropolitan areas are believed to own pagers, which have become a kind of status symbol.

As of 1993, there were 3.8 million pager subscribers in China. To meet this demand, just as with portable telephones, Japanese-affiliated makers have continued to establish joint ventures for the production of pagers inside China. Most of these operations are expected to enter full-scale production in 1994, thereby increasing demand for the microcomputer controllers (4- /8-bit), liquid crystal display (LCD) drivers, decoder ICs and intermediate frequency (IF) detection ICs (mostly Japanese made) used in the manufacture of pagers. As usual, domestic procurement of key semiconductor devices is difficult, and joint ventures engaged in the manufacture of pagers will probably have to rely on KD production for the time being.

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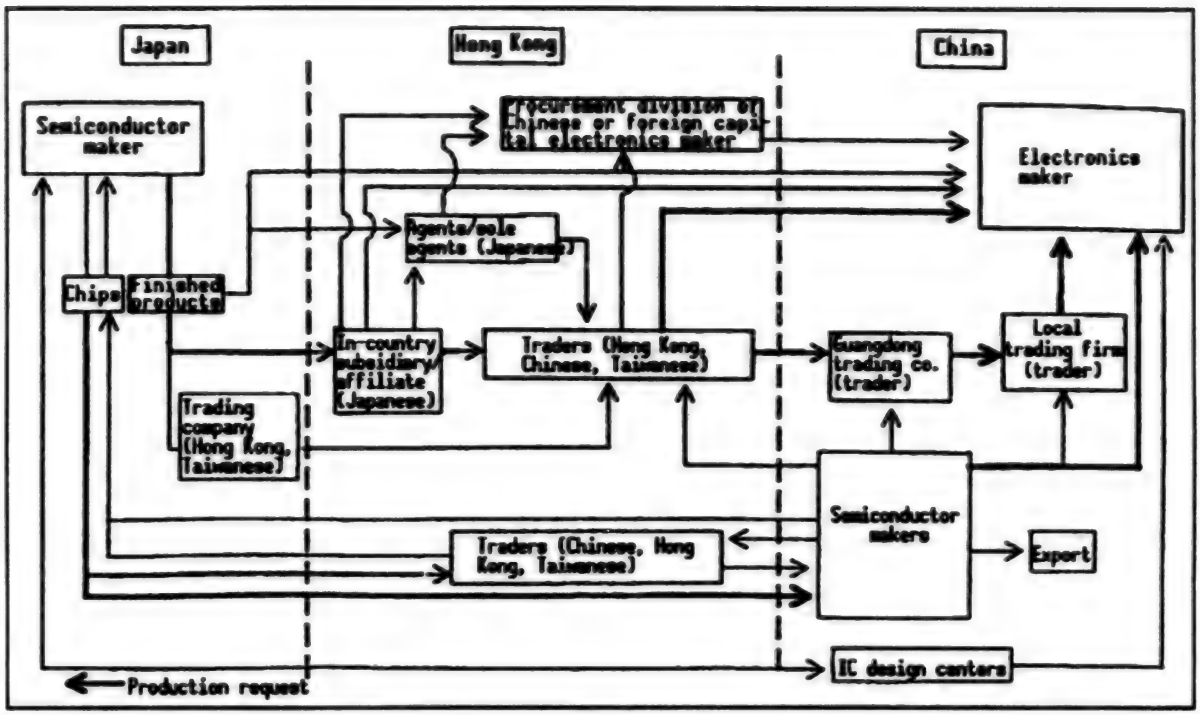

Figure 5.4.1.1 Japan-China Semiconductor Distribution Route

5.4 Semiconductor Procurement

5.4.1 Semiconductor Distribution Routes

Figure 5.4.1.1 shows the most commonly used route for exporting semiconductors (finished products) from Japan to China. As you can see, the semiconductors are shipped from a subsidiary or affiliate of the Japanese maker located in Hong Kong (some in Singapore) to China via small trading companies called "traders" (Chinese, Hong Kong or Taiwanese). This route is used to beat inflation, to recover credits and/or to divide up the exchange rate risk.

The most often used route for semiconductor chips is either direct from the Japanese semiconductor manufacturer to the Chinese semiconductor manufacturer, or via the middleman traders. The Chinese semiconductor manufacturers then perform downstream processing and sell the finished products to Chinese electronics manufacturers. And recently, China's IC design centers (discussed in more detail later on) have been getting actively involved in submitted production requests to overseas manufacturers (including Japanese makers) for ICs requiring microtechnology processing (1 micron m-class ICs).

At present, the biggest problem involved in transactions between Japanese semiconductor manufacturers and China is getting paid for the products they export there. Most of China's state-run manufacturers are short of funding and suffer from a dearth of foreign currency, which means that they often fall behind in their payments for products they import. In order to avoid this risk, Japanese semiconductor makers are forced to work through middlemen called traders to sell their products in China.

For their part, the Chinese electronics manufacturers, pressed by the need to enhance performance and turn out products that will prove competitive on the international market, must purchase the foreign-made semiconductors they require at unfavorable exchange rates (settled in yuan) from local traders. As a result, there have been recent cases of Chinese electronics makers setting up procurement bases in Hong Kong to ensure stable supplies of needed components. However, these bases are apparently not functioning as hoped, due primarily to the Chinese makers' lack of foreign currency.

5.4.2 Semiconductor Utilization by Product

Table 5.4.2.2 shows the state of semiconductor utilization by Chinese electronics manufacturers (as estimated by the EIAJ Survey Team). Currently procurable Chinese-made semiconductor products are limited to linear ICs for color TVs (upstream processing done in Japan; downstream processing done in China, for the most part) and discrete devices; most memory, microcomputers and logic ICs must still be imported from abroad.

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Table 5.4.2.2 Semiconductor Utilization

Semiconductor / Electronic equipment		Semiconductor procurement						
		MOS memory				MOS microcomputer		
		Japanese	U.S./ European	Asian	Chinese	Japanese	U.S./ European	Chinese
CTV	14-inch or smaller	—	—	—	—	O	Δ	x
	15- to 24-inch	O	—	—	—	O	Δ	x
	25-inch or larger	—	—	—	—	O	Δ	x
VTR		—	—	—	—	o	Δ	x
Radio/cassette players	Without CD	—	—	—	—	O	Δ	x
	With CD	—	—	—	—	O	Δ	x
Personal computers		O	Δ	Δ	x	x	O	x
Pagers		Δ	O	Δ	x	Δ	O	x
Portable telephones		Δ	Δ	Δ	x	Δ	O	x

Note: One-chip devices primarily foreign-made.

Procurement ratios:

O = 60% or more;

o = 30-60%;

Δ = 10-30%; x = 10% or less

Source: EIAJ Survey Team estimates

Although government policies have aided in raising the percentage of basic block color TV ICs (signal processors, etc) procured domestically, all ICs (microcomputers, dedicated logic devices) used to furnish color TVs with multifunctional capabilities (surround systems, BS tuners, remote control devices) are made overseas.

As Table 5.4.2.2 also points out, as it stands now, the majority of those semiconductors slated for use in VTRs, full-scale Chinese production of which is expected in future, as well as PCs, pagers and portable telephones, cannot be procured inside China, and will have to be imported from abroad for some time to come. However, the domestic procurement of ICs will be imperative in future if China is to expand its production of electronics equipment aimed at its domestic markets. Intel has announced the start of MPU production (downstream operations) in China, and today the rush by foreign semiconductor manufacturers to establish production capabilities inside China is continuing. With these ventures expected to come into full-scale operation during 1994, the local procurement ratio for microcomputers, logic devices and other MOS ICs is expected to rise, albeit gradually.

5.5 Semiconductor Production Trends in China

5.5.1 Overview of Production Results

(1) Current State of Semiconductor Production

China continues to expand production of discrete devices for use in consumer-oriented equipment aimed at the domestic market; a portion of China's discrete device production is slated for export. ICs, of course, are for use in advanced products, and must still be imported, either legally or illegally (smuggling), to meet the majority of demand; between roughly 15-20% of domestic demand for bipolar/linear ICs for use in TVs is met by domestic production.

In the future, in concert with its industrial policies, China's plans call for expanding its IC production capabilities, with priority on ICs for use in electric power,

However, the semiconductors fabricated at the small-scale plants distributed nationwide have a hard time taking advantage of merits of scale and are not competitive on the export market. Therefore, through a combination of moves aimed at making up for volume production technology that lags roughly 10 years behind the state of the art, i.e. weeding out unprofitable operations by privatizing state-run enterprises, enhancing production efficiency by intensifying investments, and promoting joint ventures and/or integration with foreign firms, China hopes to rapidly increase the ratio of ICs produced domestically.

China will probably base its efforts around joint ventures, and concentrate on improving peripheral industries and other aspects of the infrastructure, lowering costs, and enhancing quality and reliability. Then, in future, will most likely expand internal supply-and-demand for high-value-added IC products, while simultaneously promoting the expansion of imports in parallel to this.

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at Chinese Electronics Manufacturers (continued)

site (Production site)

MOS logic			Linear (Signal related)			Discrete devices		
Japanese	U.S. /European	Chinese	Japanese	U.S./ European	Chinese	Japanese	U.S./ European	Chinese
Δ	Δ	x	o	x	o[1]	Δ	Δ	o
Δ	Δ	x	o	x	o[1]	Δ	Δ	o
Δ	Δ	x	o	x	o[1]	Δ	Δ	o
o	Δ	x	o	x	x	Δ	Δ	Δ
O	Δ	Δ	o	x	Δ	Δ	Δ	o
O	Δ	Δ	o	x	Δ	Δ	Δ	o
Δ	O	x	Δ	—	x	Δ	Δ	x
Δ	o	x	o	Δ	x	Δ	Δ	x
Δ	o	x	o	Δ	x	o	Δ	x

According to China's national statistics, semiconductor production output at state-run enterprises during 1992 on a volume basis was as follows:

Discrete devices: 5.71 billion units (+12.7% over previous year)

ICs: 140 million units (+11.7% over previous year)

As in the past, the ratio of overall semiconductor production accounted for by discrete devices is larger than that for ICs, but IC production is steadily increasing.

These same statistics indicate that semiconductor production output on a value basis for 1992 was as follows:

Discrete devices: 4.36 billion yuan (-16.2% from previous year)

ICs: 620 million yuan (+18.8% over previous year)

The scope of production for semiconductors overall thus worked out to 4.98 billion yuan (-12.9% from previous year).

The average unit cost for semiconductors as a whole came to 0.9 yuan (- 18% from previous year), with discrete devices working out to 0.8 yuan (- 20% from previous year) and ICs equalling 4.3 yuan (+7% over previous year).

As before, diodes (85%) account for the majority of all discrete devices produced in China, and bipolar/linear ICs (65%) for use in consumer products are the most numerous type of IC produced. Although high cost areas have not been completely omitted, the effects of cost-lowering measures are steadily improving China's semiconductor production capabilities.

Table 5.5.1.1 Production Output and Average Unit Costs

		1989	1990	1991	1992	1993 Outlook
Production by volume (Millions of units/year)	Discrete devices	2,395	3,110	5,060	5,710	Increase
	ICs	96	97	128	143	170
	Total semiconductors	2,491	3,207	5,188	5,853	Increase
Production by value (Millions of yuan/year)	Discrete devices	3,590	3,700	5,200	4,360	Same
	ICs	427	588	520	618	Increase
	Total semiconductors	4,017	4,288	5,720	4,978	Increase
Unit cost of production (Yuan/unit)	Discrete devices	1.5	1.2	1	0.8	Decrease
	ICs	4.4	6.1	4.1	4.3	Increase
	Total semiconductors	1.6	1.3	1.1	0.9	Increase

Source: China's Electronics Industry Yearbook

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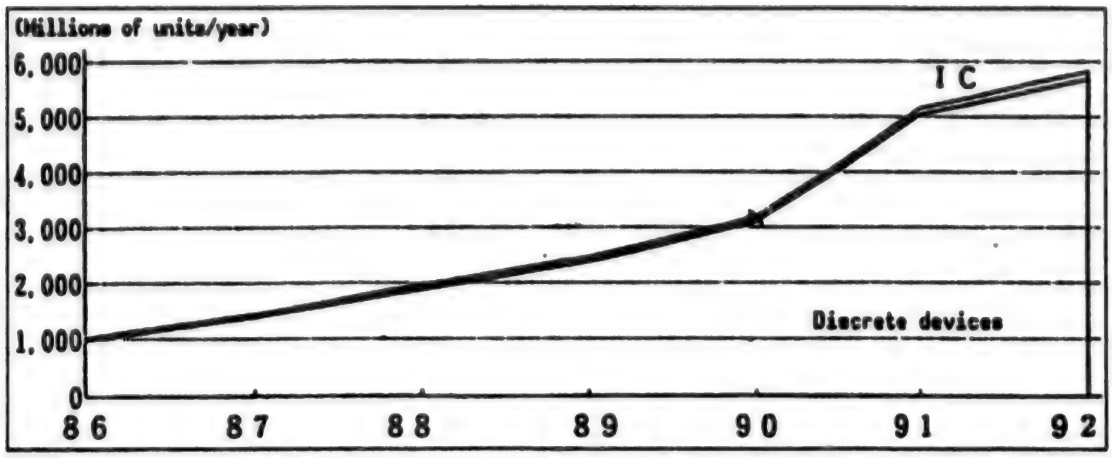
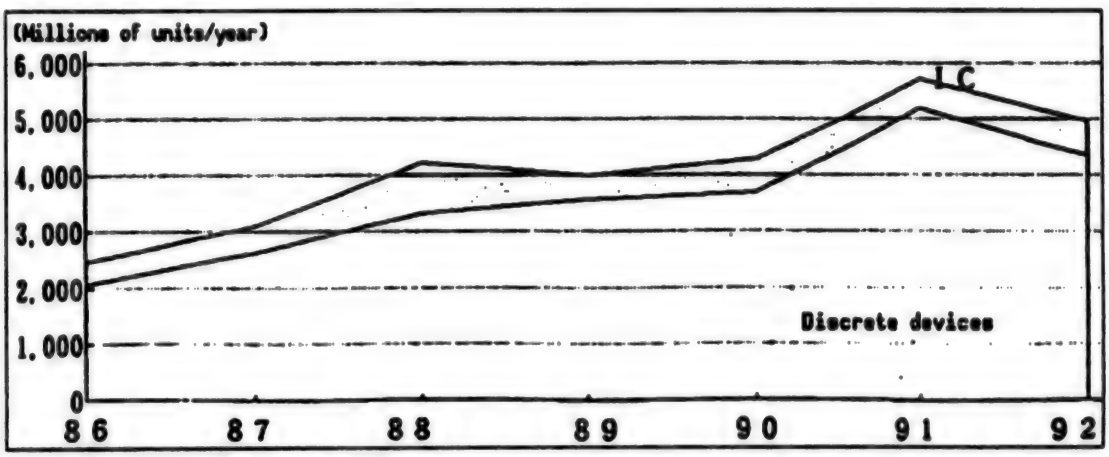


Source: China's Electronics Industry Yearbook

Figure 5.5.1.2 Production Output from 1986-92 (By Volume)



Source: China's Electronics Industry Yearbook

Figure 5.5.1.3 Production Output from 1986-92 (By Value)

Table 5.5.1.4 Transition of Production Output at State-run Enterprises and Joint Venture Companies (Unit: %)

		1989	1990	1991	1992	1993	1994	1995
Discrete devices	State enterprises	89.5	88.8	89.9	89.6	90	90	90
	Joint ventures	10.5	11.2	11.1	10.4	10	10	10
ICs	State enterprises	100	100	100	98.2	95	80	70
	Joint ventures	0	0	0	1.8	5	20	30

Source: EIAJ Survey Team estimates

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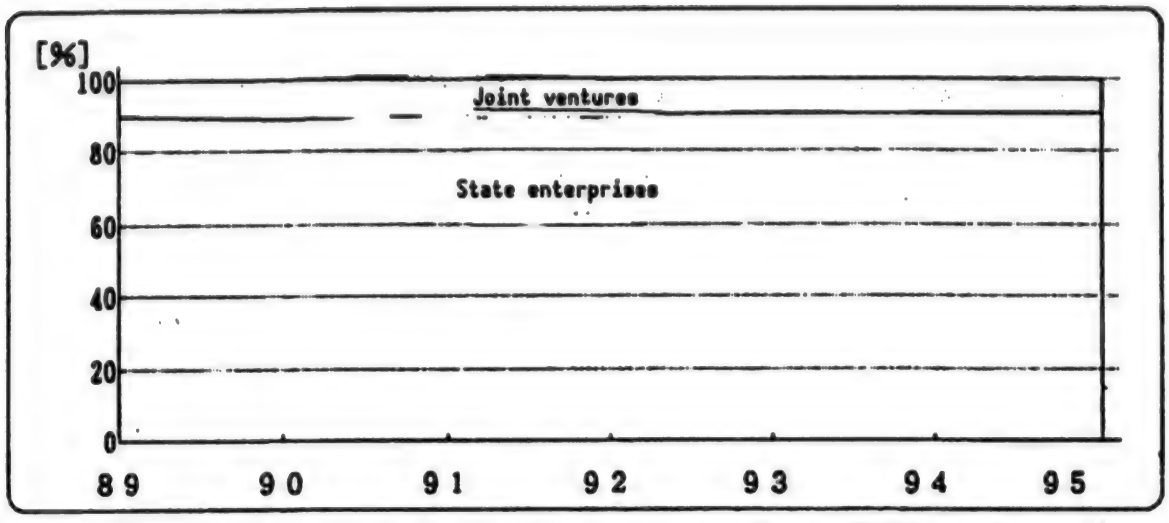
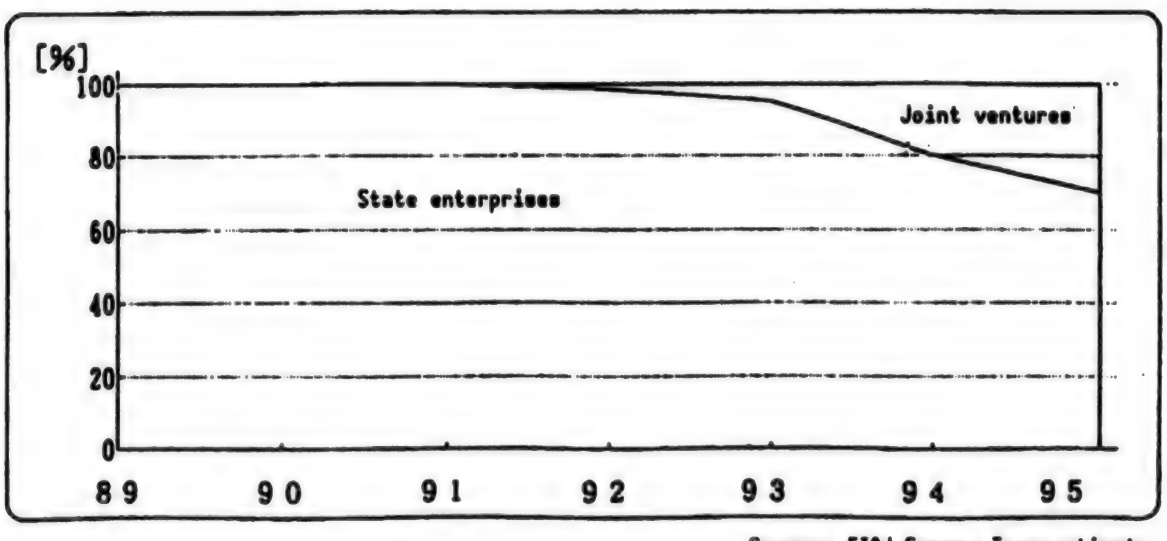


Source: EIAJ Survey Team estimate

Figure 5.5.1.5 Production Output at State-Run Enterprises and Joint Ventures Companies from 1989-95 (Discrete Devices)



Source: EIAJ Survey Team estimate

Figure 5.5.1.6 Production Output at State-run Enterprises and Joint Ventures Companies from 1989-95 (ICs)

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(2) Discrete Device Production Output

Figure and Table 5.5.1.7 provide 1992 figures on discrete device production output and composition by China's state-run discrete device manufacturers (310 enterprises).

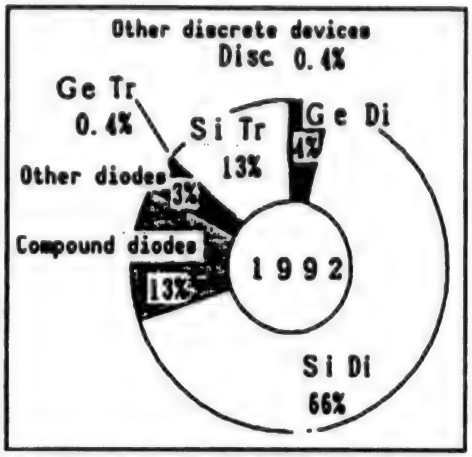

Figure 5.5.1.7 Discrete Device Production Output and Composition

Table 5.5.1.7 Discrete Device Production Output and Composition (Units: millions of units/year)

Product category	1991		1992		1993
	Output	Growth from previous year	Output	Growth from previous year	Outlook
Germanium	168	-13%	244	45%	
Silicon	3,604	71%	3,740	4%	
Compound	66	148%	732	11%	
Other	20	80%	182	835%	
Total diodes	4,431	72%	4,914	11%	Same
Germanium	9	-55%	22	149%	Increase
Silicon	582	17%	737	27%	
Compound					
Total transistors	591	14%	759	28%	Increase
Electric power devices	9	79%	15	64%	Increase
Other discrete devices	20	80%	22	10%	
Total discrete devices	20	80%	22	10%	

Sources: China's Electronics Industry Yearbook and EIAJ Survey Team estimates

Total production by volume: 5,709 million units (+13% over previous year)

Total production by value: 4.36 billion yuan (-16% from previous year) (equivalent of 56.7 billion yen)

Product breakdown: Diodes 86% (+11% over previous year)

Transistors 13% (+28% over previous year)

Others (power, LEDs) 1% (+10% over previous year)

These figures show a marked increase in transistor production, reflecting the government's policy of making the transition from diodes to transistors as set forth in the Eighth Five-Year Plan.

Also, the 64% growth rate exhibited by discrete devices for use in electric power applications was considerable. More specifically, these consist of power transistors for use in color TVs, typical examples of which were the 200,000 units per year produced by the China Huajing Electronics Group and the 100,000 units per year put out by Jilin Semiconductor.

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Table 5.5.1.8 shows the production output by value for China's principal discrete device manufacturers for 1992. Production output at three of the leading firms on a volume basis was as follows:

China Huajing Electronics Group: 380 million transistors/year

Shanghai Radio Works 17: 710 million diodes/year

Guangdong Chenghai Semiconductor: 180 million diodes/year

Table 5.5.1.8 1992 Production Output by Value for China's Principal Discrete Device Manufacturers (Millions of yuan/year)

	Enterprise name	Output
1	China Huajing Electronics Group	196
2	Guangdong Chenghai Semiconductor Device Plant	105
3	Tianjin Zhonghuan Semiconductor Company	73
4	Sichuan Leshan City Radio and Electronics Plant	65
5	Jiangsu Rugao Radio and Electronics Plant	52
6	State-run Plant 875	50
7	Guangdong Foshan City Semiconductor Device Plant	47
8	Jinan Semiconductor Plant	41
9	State-run Plant 970	35
10	Shandong Semiconductor Plant (Plant 8070)	33
Total		697

* These 10 enterprises account for 16% of total production output.

Source: China's Electronics Industry Yearbook

By expanding its production capabilities for discrete devices, China has reached the point where it can handle domestic demand with domestically-produced devices, and is now putting as much effort as possible, cost-wise, into exporting these devices. Exports of discrete devices by value during 1992 worked out to 470 million yuan (¥ 6.11 billion). The amount of foreign investment in the discrete device field in 1992 came to US$4.7 million.

Table 5.5.1.9 Exports of Discrete Devices

			1989	1990	1991	1992
Discrete devices	Exports	By volume (million of units)	603	1,311	2,418	1,405
		By value (Millions of yuan)	336	422	818	475
	Imports	By volume (Tens of thousands of units)	—	—	—	—
		By value (Tens of thousands of yuan)	—	—	—	—

Source: China's Electronics Industry Yearbook

(3) IC Production Output

IC demand in China is growing rapidly (in 1992, demand was between 650-670 million units, up 80% over the previous year), but its self-sufficiency ratio is low. The official self-sufficiency ratio is given as 30%, but in actuality China is extremely dependent on both legal and illegal imports, and its real self-sufficiency ratio is probably closer to 15-20%. The Eighth Five-Year Plan calls for enhancing investment efficiency and improving mass production capabilities by intensifying operations at the distributed IC plants in order to achieve more than 50% self-sufficiency.

IC production output and composition during 1992 are shown in Table 5.5.1.10. Total IC production output by volume worked out to 142.59 million units (+12% over the previous year), and by value came to 618 million yuan (roughly ¥ 8 billion) (+19% over the previous year).

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Table 5.5.1.10 IC Production Output and Composition

Product category	1991		1992		1993 outlook
	Output	Growth over previous year	Output	Growth over previous year	Output
Bipolar digital ICs	523	154%	517	-1%	Decline
MOS Digital ICs	258	-41%	441	71%	Increase
Interface ICs			32		
Linear ICs	1,289	486%	248	-81%	Same
Power ICs	256	5%	766	199%	Increase
Dedicated consumer equipment ICs	6,905		9,107	32%	Increase
Others	3,569		3,148	-12%	
Total	12,800	14%	14,259	33%	17,000

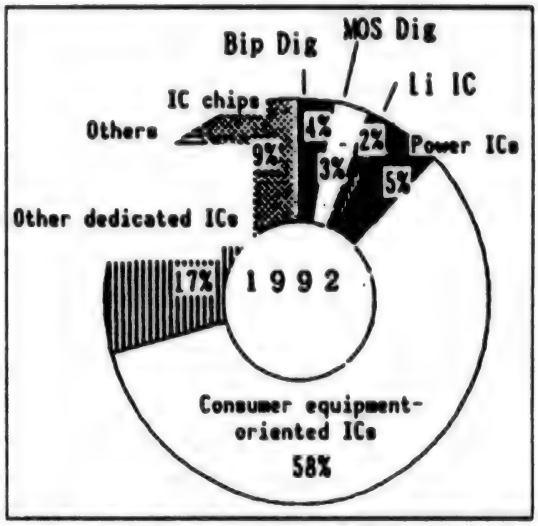
Sources: China's Electronics Industry Yearbook and EIAJ Survey Team estimates

The main driving force behind IC production in China is the dedicated consumer equipment IC (growth of which has been proportional to TV production). In 1992, these ICs accounted for 64% of China's overall IC output by volume.

As a result, dedicated consumer equipment ICs have accounted for most of the dedicated ICs produced in China between 1989 and 1992. For example, these ICs accounted for 82% of all dedicated ICs produced in 1989, for 84% in 1990, 78% in 1991 and 88% in 1992.

In the realm of bipolar digital ICs, the main thrust of development efforts is aimed at 74/54 TTL and emitter-coupled logic (ECL) devices. At present, with its immature production-supply system, China has no choice but to rely on imports for most of these ICs, but in future, we can expect to see the government endeavor to rapidly expand production of memory, microprocessors and ASIC MOS ICs for use in switching equipment and other communications applications, office automation (OA) equipment and PCs. It is also felt that increased production by foreign capital firms operating in China will be promoted in parallel with increases in the types and volumes of customized ICs imported in response to manufacturing requests made to overseas makers for the production of ICs designed in China.

IC production by volume in 1993 is expected grow roughly 21% to reach 170 million units.



Source: China's Electronics Industry Yearbook

Figure 5.5.1.11 Breakdown of IC Production Output

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Table 5.5.1.12 1992 Production Output by Value for China's Principal IC Manufacturers (Millions of yuan/year, tens of thousands of units/year, yuan/unit)

	Enterprise name	Output by value	Output by volume	Unit cost
1	China Huajing Electronics Group	23,030	3,040	7.6
2	Shanghai Beiling Company	11,100	630	17.6
3	Huayue Microelectronics Co., Ltd.	8,060	2,000	4.0
4	Xinhui Guifeng Microelectronics Company	5,410	1,470	3.7
5	Beijing Semiconductor Device Plant 6	4,210	560	7.5
6	Jinan Semiconductor Plant	3,310	420	7.9
7	Gansu Tianguang IC Plant	2,510	240	10.5
8	Shenzhen Fengguang IC Company	2,030	1,220	1.7
9	Shanghai Radio and Electronics Plant 14	1,340	260	5.2
10	Xiamen Hualian Electronics Co., Ltd.	1,060	410	2.6
	Total	62,060	10,250	6.1

* These 10 enterprises account for 72% of total IC production output.

Source: China's Electronics Industry Yearbook

Table 5.5.1.13 Imports of ICs from 1989-92

			1989	1990	1991	1992
ICs	Exports	By volume (Millions of units)	9	8	10	NA
		By value (Millions of yuan)	1	1	5	74
	Imports	By volume (Millions of units)	117	188	249	188
		By value (Millions of yuan)	169	209	257	863

Source: China's Electronics Industry Yearbook

5.5.2 Semiconductor Production Forecast

(1) Production Plans and Forecasts

According to China's Eighth Five-Year Plan, semiconductor production goals for 1995 are as follows: 12.5 billion discrete devices, of which production capacity for transistors is 10.0 billion units, for optoelectronic devices is 1.5 billion units, and for sensors is 1.0 billion units; and 600 million ICs (of which 50% by volume are produced domestically), with production capacity reaching 800 million units.

Actual semiconductor production output during fiscal 1992 worked out to roughly 5.7 billion discrete devices and about 140 million ICs. In order to achieve the 1995 production objectives cited above, discrete device production capacity will have to increase by 30% and that for ICs by roughly 60% within the next three years. Judging from the current state of production at state-run semiconductor enterprises, China will have an extremely difficult time realizing their IC production goal.

At present, IC production is growing at an annual rate of roughly 10%. To achieve the 1995 IC production objective, it will be imperative that China's five principal state-run IC makers, as well as the big foreign capital joint venture operations being actively promoted by the Chinese government, drastically expand production of MOS products.

A look at semiconductor production in China since the start of the 1990's shows that silicon transistors, LEDs and power devices have each grown at the rate of roughly 30% per year, boosting the overall growth rate for discrete devices. If this trend continues in future, China has a fair chance of achieving its production goals in the area of discrete devices.

With this in mind, the Survey Team based its estimates on the following average annual growth rates:

Discrete devices by volume: +10%/year until 1995, +7%/year until 2000

ICs by volume: +40%/year until 1995, +25%/year until 2000

Discrete devices by value: +5%/year until 1995, +3%/year until 2000

ICs by value: +50%/year until 1995, +25%/year until 2000.

With the relaxation of COCOM restrictions, China should be able to import advanced technology and equipment between the years 1995-2000, and the foreign capital firms should be able to achieve full-scale production during this period. These events are expected to result in growth by volume of ICs for use in industrial applications, as well as increases in discrete device production slated for the export market. And increased production of high-priced products is expected to drastically expand semiconductor production on a value basis.

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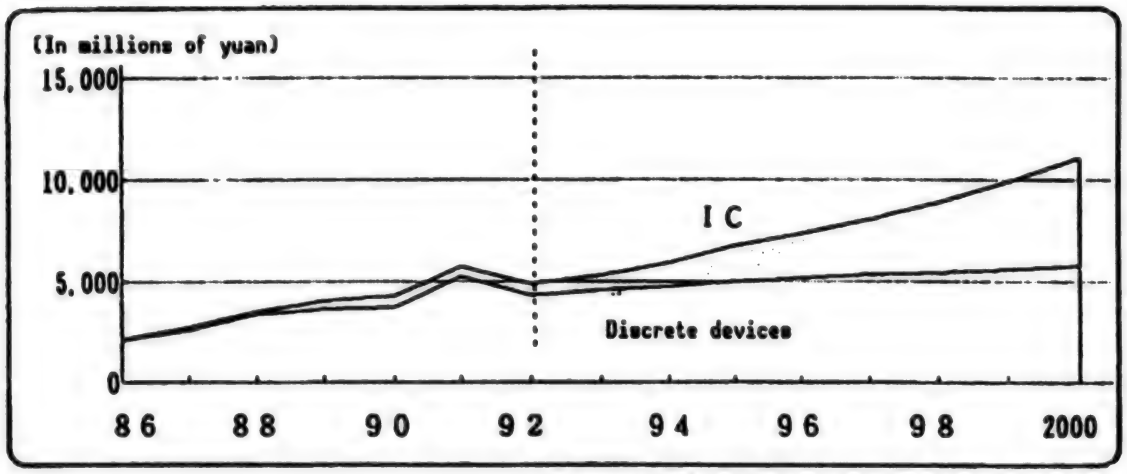
Table 5.5.2.1 Semiconductor Domestic Production Forecast

	Product category	1991	1992	1993	1194	1995	2000
Output by volume (Millions of units/year)	Discrete devices	5,060	5,710	6,280	6,910	7,600	10,660
	ICs	120	140	170	250	350	1,100
	Total semiconductors	5,180	5,850	6,450	7,160	7,950	11,760
Output by value (Millions of yuan/year)	Discrete devices	5,200	4,310	4,530	4,750	4,990	5,790
	ICs	520	620	780	1,170	1,760	5,370
	Total semiconductors	5,720	4,930	5,310	5,920	6,750	11,160
Output growth ratios by volume (%/year)	Discrete devices	63	13	10	10	10	7
	ICs	32	17	20	47	40	25
	Total semiconductors	62	13	10	11	11	8
Output growth ratios by value (%/year)	Discrete devices	41	-13	5	5	5	3
	ICs	-12	20	25	50	50	25
	Total semiconductors	27	-24	8	11	14	11

Note) Figures for 1994 and beyond include those for joint venture firms as well.

Sources: China's Electronics Industry Yearbook and EIAJ Survey Team estimates.

5.6 Semiconductor Technology Trends in China



Sources: China's Electronics Industry Yearbook and EIAJ Survey Team estimates

Figure 5.5.2.2 Domestic Production by Value from 1986 to 2000

5.6.1 Overview

By introducing foreign capital, the Chinese government hopes to enhance the level of its advanced technology, and accelerate the pace at which it catches up, technologically, with the rest of the world. This introduction of foreign capital is also paving the way for facilitating the rapid import of those products which China is incapable of producing domestically.

China is growing increasingly confident of its ability to produce discrete devices, and bipolar and linear ICs on its own, but when it comes to MOS ICs and the cultivation of peripheral industry technologies, it is counting on exchanges with overseas corporations.

China's mass production semiconductor process technology is at the level where it can handle 4-inch wafers and features sizes between 2-3 microns. By 1994, China wants to be mass producing complementary metal-oxide semiconductor (CMOS) devices with 1- to 1.2-micron feature sizes on 6-inch wafers, and by 1995 aims to achieve submicron features sizes of 0.8-microns.

In the area of IC design, the Survey Team had the opportunity to visit the Beijing Integrated Design Center and the Shanghai Jiaotong University among others, where efforts are being made to raise the level of China's product development design by using advanced workstation-based systems to actively revolutionize computer-aided engineering (CAE) technology for use in both the hardware and software aspects of applications-specific ICs (ASICs). As a fabless industry, IC design is making rapid progress in the enhancement of technology levels.

China is on its way toward extricating itself from downstream processes such as inspections, assembly and reliability assurance processes for discrete devices, but the

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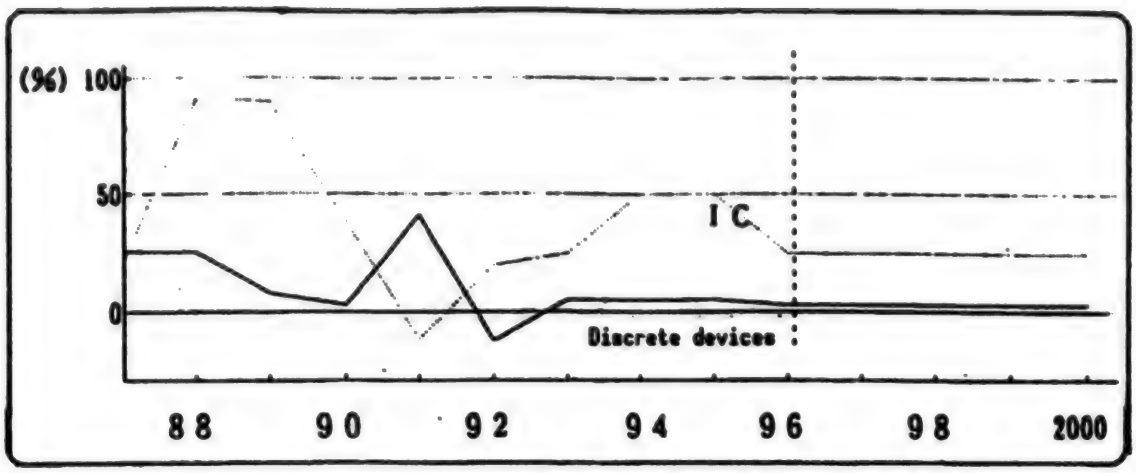


Sources: China's Electronics Industry Yearbook and EIAJ Survey Team estimates

Figure 5.5.2.2 Domestic Production by Volume from 1988 to 2000

burden for this, too, will be placed on the results achieved by foreign capital joint ventures over the next one or two years. As an example of new technology, China is becoming highly oriented toward surface mount technology (SMT) at the development stage of communication ICs.

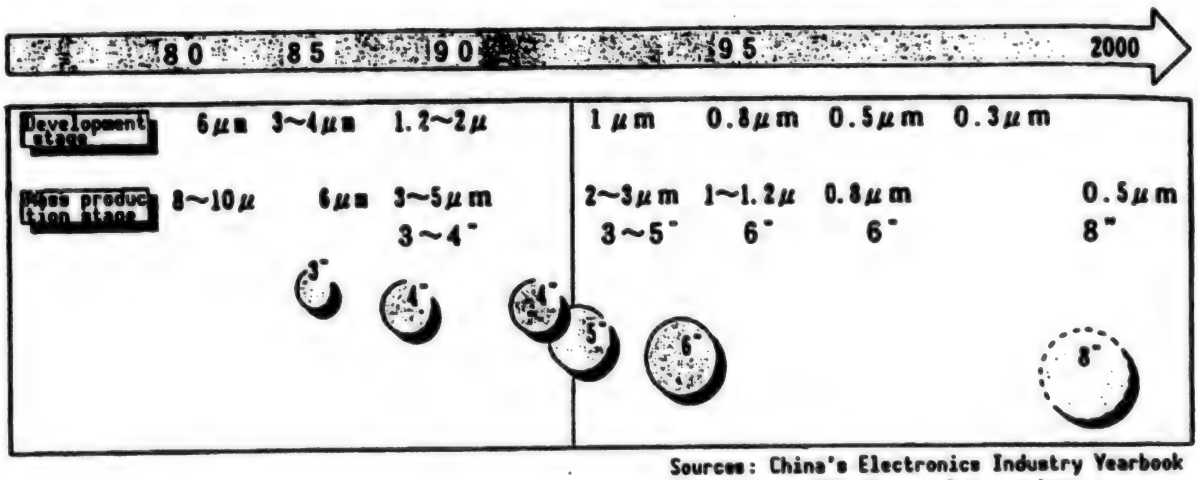
An important task in future will be the joint furthering of efforts aimed at expanding domestic production of raw materials, dies, fabrication equipment and other peripheral industry products, and improving technology levels. The rapid advancement of key technologies in this area as well will depend upon positive joint ventures between state-run enterprises, universities, research institutes and overseas corporations.

5.6.2 Development Trends in Process Technology

The level of China's process technology is such that it is currently capable of producing IC prototypes with 1- to 1.2-micron feature sizes, and can mass produce ICs with 2- to 3-micron geometries. But the main thrust of China's mass production efforts goes into fabricating ICs with feature sizes in the 3- to 5-micron range on 3- to 4-inch wafers. However, by 1994-95, joint ventures with overseas firms may enable China to achieve volume production of ICs with 0.8- to 1-micron geometries from 6-inch wafers.

5.6.3 Product Development Trends

Bipolar ICs are being mass produced in China primarily for use as signal processors in color televisions.



Sources: China's Electronics Industry Yearbook and EIAJ Survey Team estimates

Figure 5.6.2.1 IC Technology Trends

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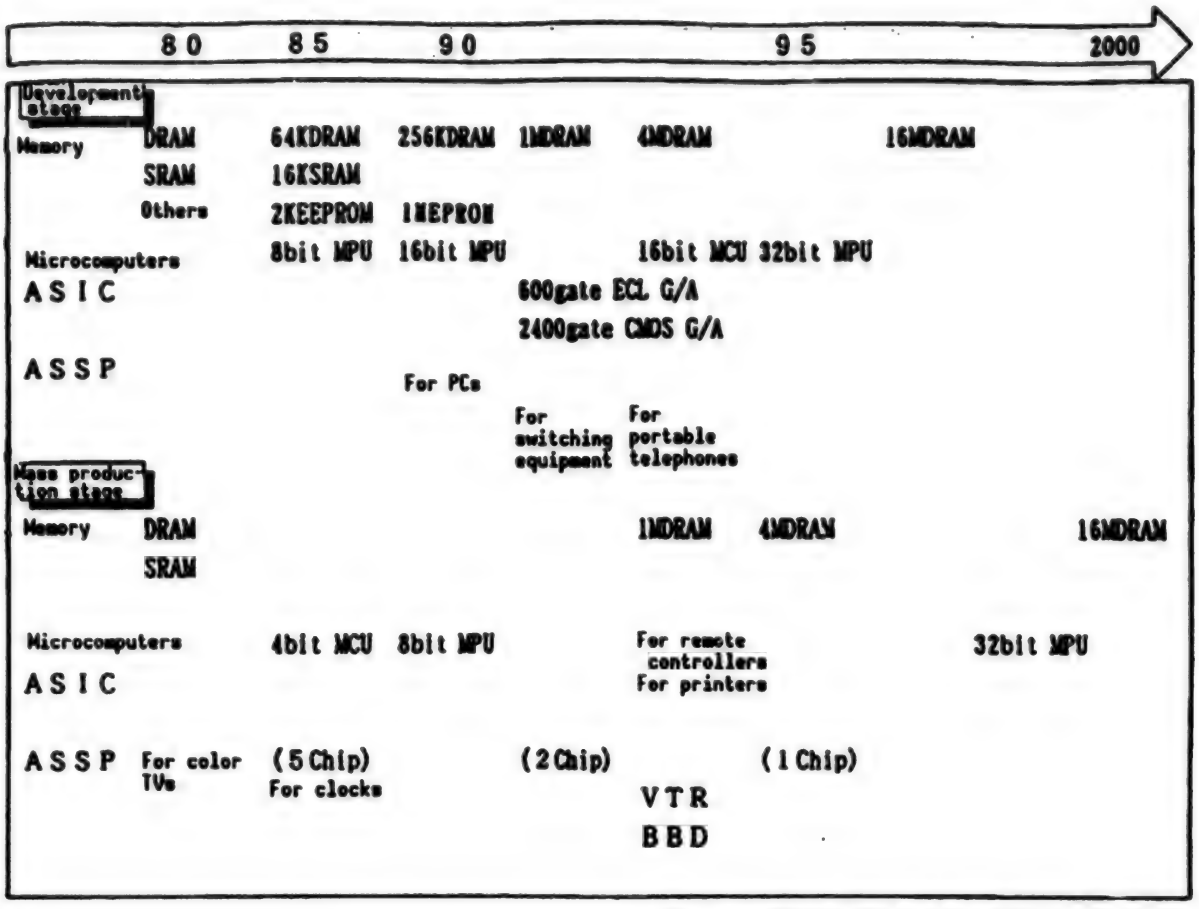

Sources: China's Electronics Industry Yearbook and EIAJ Survey Team estimates

Figure 5.6.3.1 IC Product Development Trends

China still depends on imports for practically all of its MOS ICs. However, the government is expanding the operations of its IC design centers in an effort to enhance its product development design capabilities, and has commenced designing IC products for use in color TVs, VTRs, and PCs in the order of greatest domestic market demand.

Table 5.6.3.2 shows achievements made in the area of semiconductor-related development in 1992. In response to new market requirements, China rapidly increased development work on LSIs for use in karaoke machines, video cameras, printers and remote controllers.

In the future, China plans to expand development of IC products for use in PCs and communications-related applications.

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Table 5.6.3.2 List of IC Products Developed During 1992

Development results	Developer
Eight melody musical timer position indicator interface	Shanghai, Changjiang IC Design Application Company
Dedicated telephone IC	Xinhui Guifeng Microelectronics Company, Xiamen Hualian Electronics Co., Ltd.
Crystal clock IC	Huashan Electronic Device Company
TV remote controller IC	Shanghai Beiling Company, China Huajing Electronics Group
Sound controller High-precision operational amplifier	State-run Plant 4435
Voltage regulator	Beijing Semiconductor Device Plant
Audio power amplifier	Shanghai Radio Plant 19
BBD PLL VCO Telephone ringer Pulse dialler 12-bit A/D IC Magnetic card reader IC Clock generator AM receiver	China Huajing Electronics Group
TV channel selector Remote controller electronic switch Printer ASIC Surround IC Communication interface Accumulator	Huayue Microelectronics Co., Ltd.

Source: China's Electronics Industry Yearbook

5.6.4 Design Technology

The thinking behind China's IC design technology is based on the IC design system employed in the United States and uses a software/hardware construction. China's energetic technical tieups with U.S. firms has enabled it to achieve a relatively high level of technology in this area.

China's Ministry of Electronics Industry and the LSI Research Institute at the Shanghai Jiaotong University have succeeded in developing a design system and are concentrating on propagating it as China's version of a CAE system. This development has resulted in the installation of the "PANDA" system at 20 some locations inside China under a plan to increase its utilization as China's standard core technology. China is also pushing forward with joint development work with U.S. software makers as part of its plans to develop a VHDL system by 1995.

Table 5.6.4.1 List of China's Design Centers

Subordinate to the Electronics Industry Department: 10 ('93)	The largest, BIDC
Private: around 60 locations	Expected to be expanded in the future
Beijing IC Design Center (BIDC)	Computer-aided design (CAD) system technology development, IC design
LSI Research Institute at Shanghai Jiaotong University	CAD system technology development, IC design
Chengdu University of Electronics, Science and Technology	CAD technology development
Fudan University	IC design
Metallurgy Laboratory at the Shanghai School of Science and Technology	IC design
Shanghai Changjiang IC Design Application Company	IC design
Shenzhen Tian Company	IC design
Other: Design centers at various universities	IC design

Source: EIAJ Survey Team

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At the Beijing IC Design Center (BIDC), which the Survey Team had the opportunity to tour this trip, they have designed roughly 200 kinds of ICs over the past eight years, and are currently orienting their business operations toward design work using ASIC techniques.

BIDC is capable of designing 1-micron class gallium arsenide ASICs, and have successfully designed gate arrays in the 20,000-gate class. ICs with 2- or 3-micron geometries are manufactured inside China, but the fabrication of ICs with feature sizes of 1- to 1.5-microns or less is consigned to overseas manufacturers.

BIDC is at the stage where it is developing cell-based design and mixed signal design as future technology. The Center is targeting the development of ICs for communications, PC, self-control and consumer products (remote controllers, etc.) uses in particular.

Also, the color TV manufacturer Shanghai Electronics Plant 1 has already started up an ASIC development group, and there are increasing signs that IC design centers being organized inside private companies are progressing along ASIC lines.

5.6.5 Testing Technology

China's plans call for the domestic development and manufacture of testing systems, but its capabilities in this area are still immature, requiring that it rely almost entirely on testing systems imported from the United States, Japan and other foreign countries.

Testing programs are being developed at IC design centers for use in evaluation, and are at the stage where they are ready to be applied at the mass production level.

5.6.6 Assembly Technology

Packaging technology is used primarily in the volume production of diodes, transistors and TTL. China manufacturers 16- to 60-pin class dual-in-line packages (DIPs) and 64- to 128-pin class leadless chip carriers (LCCs).

Research and development on assembly technologies is being actively carried out between government and private companies, and industry and academia, as seen at the Beijing Electronics Association's Packaging Group. China plans to achieve advanced technologies such as surface mount technology (SMT) within the next three years via future tie-ups with overseas corporations (such as that for ICs for Motorola's portable telephones).

China is also in the process of developing the technology needed to manufacture quad flat pacs (QFPs) in the 100-pin class, and is rushing to achieve domestic production of related equipment, such as mold dies, lead frame dies, wire bonders, and die bonders.

These new trends indicate that China's need to enhance its assembly technologies to the SMT device level and to expand its production capabilities is steadily rising in line with the rapid increase in the domestic assembly and production of substrates for use in PCs.

5.6.7 Overview of Semiconductor Peripheral Industries

China's semiconductor raw material and manufacturing equipment industries—the semiconductor peripheral industries—are still immature, requiring that China depend largely on overseas manufacturers for these products. The Eighth Five-Year Plan places priority on policies designed to cultivate the raw materials and other peripheral industries in order to emphasize the semiconductor industry position as the core of the electronics industry (See Table 5.6.7.2).

Table 5.6.7.1 List of Principal Peripheral Industry Companies

Key glass mask manufacturers	Chinese Academy of Sciences (CAS) Beijing Microelectronics Institute CAS Shanghai Institute of Metallurgy China Huajing Electronics Group	(2- to 5-micron class)
Silicon wafers, compound semiconductors	China Sijia Semiconductor Materials Co. (Xian) China Huajing Electronics Group	
Gas	Shanghai Liquified Gas Co., Ltd. (Shanghai)	Ultra-pure Gas Production Air Liquid Group [phonetic] (France) wholly-owned
IC equipment maintenance	China Educational Electronics Company (Shenzhen)	

Source: EIAJ Survey Team

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Table 5.6.7.2 Eighth Five-Year Plan Material Production Goals

Material category	Goals	Company
Silicon wafers (4- to 5-inch)	2 million/year (120 million yuan/year)	Sijia Emei Semiconductor Materials Plant Luoyang Semiconductor Materials Plant Huanshan Semiconductor Materials Plant Joint venture between Emei Semiconductor Materials Plant and a foreign-capital firm
EPI wafers 3- to 4-inch single crystal	200,000/year 200,000 tons/year	
Silicon wafers (6-inch)		Beijing Nonferrous Metals Institute
Polycrystalline silicon (3- to 4-inch)	30 tons/year	Shanghai Quartz Glass Plant
Resist	8 tons/year	Beijing Chemical Testing and Manufacturing Plant Suzhou Electronics Materials Plant
Wire	200-400 kg/year 17.5-100 micron)	Precious Metals Institute (Kunming) Beijing Nonferrous Metals Institute
Lead frames Copper alloy Nickel alloy Lead frame process	 2-4K tons/year 400-500 kg/year LSI lead frames (for LSIs)	 Luoyang Copper Processing Plant Shaanxi Precision Alloy Plant Xiamen Yonghong Electronics Co. Shandong Zhucheng Radio and Electronics Parts Plant Wuhan Radio and Electronics Equipment Plant
Resins	2K tons/year	Lianyungang Electronics Equipment Plant China School of Chemistry

Source: EIAJ Survey Team

However, China's almost total dependence on overseas sources for its manufacturing equipment, wafers, resins, lead frames and wiring materials is expected to continue through 1995 as well.

The Survey Team's investigation and interviews revealed that China is producing 4-inch epitaxial reactors, high-pressure chemical vapor deposition (CVD) reactors, coater developers, 4- and 5-inch quartz tubes and heat distribution furnaces, and is at the prototype stage of developing 2- and 3-micron class steppers, dry etchers, wire bonders and die bonders.

China is capable of producing its own 4-inch class silicon wafers and is in the process of developing 5-inch wafers. However, it still relies heavily on imports from the United States and Japan for its supplies of 4- to 6-inch silicon wafers.

China imports most of its lead frames from Japan and Taiwan, but is manufacturing lead frames for use with QFP and leaded-chip carriers plastic (PLCC) in Xiamen.

As for wire, 50-micron diameter wires are supplied domestically, but domestically-produced 25-micron class wires are not up to mass production standards from the aspects of quality and reliability, and are mostly imported from Japan and Singapore.

China is now capable of the domestic production of 5-inch class glass masks for imaging 2- to 3-micron design rules, but for geometries of 1-micron and smaller, China imports its glass masks from Japan and Taiwan.

In order to break away from its reliance on imports, China has begun to establish materials companies such as the "China Xikei [phonetic] Semiconductor Materials Company (Xian)" which will supply China's semiconductor makers with silicon wafers, compound semiconductors, high-purity metals and alloys, and high-purity gases.

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5.7 Overview of Semiconductor Companies
5.7.1 Company Location Map

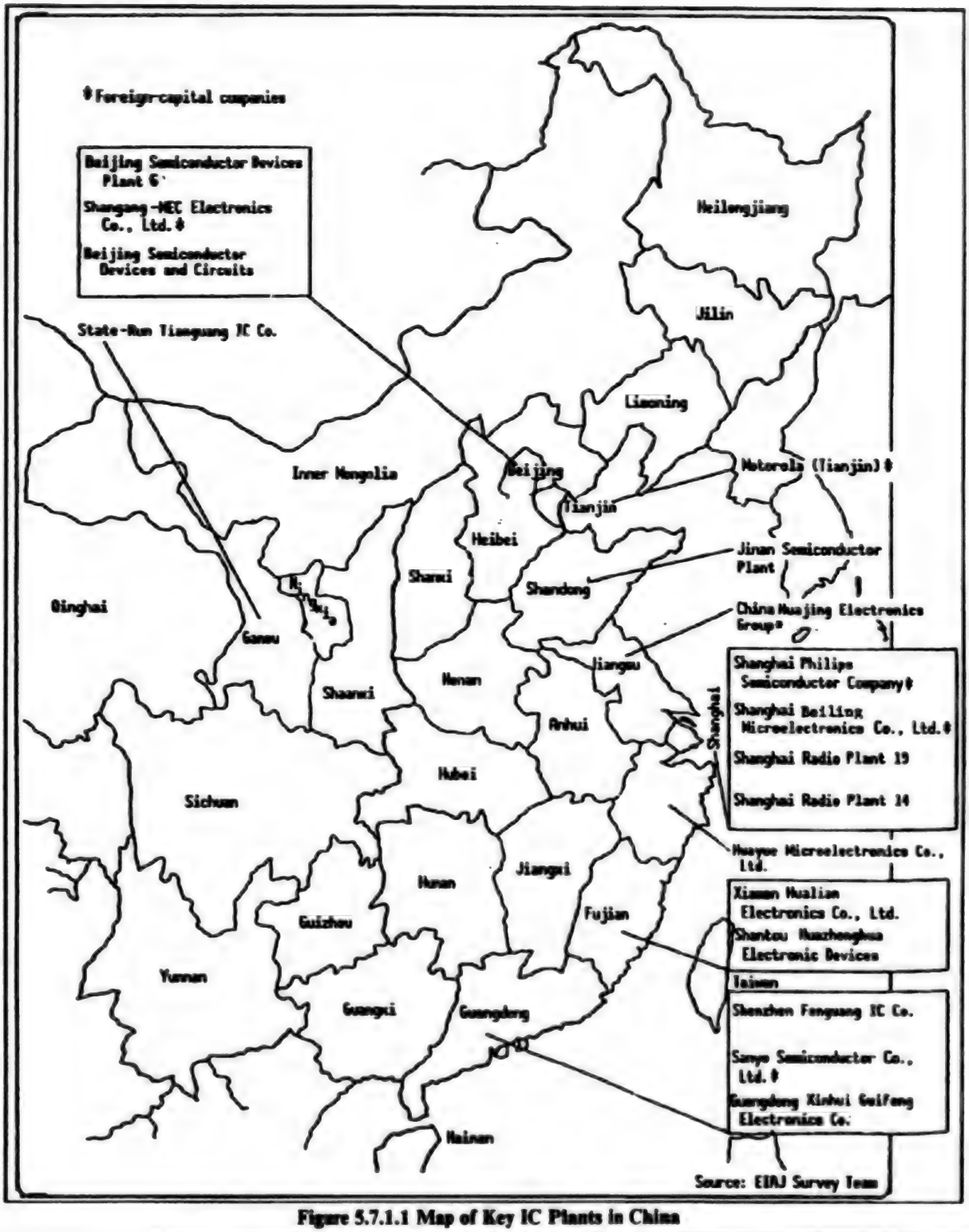

Figure 5.7.1.1 Map of Key IC Plants in China

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5.7.2 Overview of Companies Visited

Table 5.7.2.1 Visited Company

Company name (representatives)	Beijing IC Design Center (BIDC) (Director: Wang Qinsheng; General Manager: Zhang Huiquan)		Founded September 1986
Address	No. 1, Gaojiamen, Chaoyang District, Beijing TEL: 466 5990 FAX: 408 1382		Size (lot)
Employees	Total personnel: 150 (1993) Designers: 135 (90%) (of which roughly 20 are systems engineers)	~250 (forecast for 1995) Master 40% Average age: 29	Capitalization Investment: 160 million yuan (December 1994)
Businesses	IC design and CAD system development IC design (accepts request for designs and consigns out manufacturing work) Development of IC applications systems FPGA (Altera [phonetic]) agent	Areas emphasized ASICs for use in communications, PC peripherals, automatic control and measurement instruments and TV remote controllers Propagation of the "PANDA" system	
Manufacturing lines	Test line on first floor	Revenues: 1990 = 25 million yuan (60%)	
Equipment	30 SUN SPARC STATION2s, 2 Hewlett Package workstations 1 SUN Surber 960 and 2 DAISY workstations		
Design achievements	Have designed approximately 200 different types of ICs since 1986, to include a 1-micron gate array in 20K gate class. Have also done reverse engineering on 8088/8086/8254/8250/8284/8283 etc. Main design work in realm of 3K-5K gate arrays (80%)		
Research themes	Development of an advanced CAE system (VHDL), and IC applications systems		
Overseas exchanges	Wafer manufacturing consignments: for 3- to 5-micron geometries--China and Hong Kong for 2- to 3.5-micron geometries--Taiwan, Singapore, and Hong Kong for 1.2- to 2-micron geometries--South Korea, Taiwan, and Singapore for 0.8- to 1.2-micron and smaller geometries--United States, Japan, and South Korea Mask manufacturing consignments: for 1.5- to 1-micron and smaller imaging--via Taiwan to Japan		
Tour impressions	This company appeared to lag about five years behind the West, but it has achieved design results under a U.S.-style design environment, and is a model for other design centers in China. It is felt that BIDC's aggressive interchanges with U.S. companies will enable it to improve the value-added of China's IC products. Similar design centers will be established in various areas of the country in the future, and are expected to rapidly advance China's product development capabilities.		

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Table 5.7.2.2 Visited Company

Company name (representative)	Beijing Semiconductor Devices Plant 6 (Plant Manager: Gong Yuxiang)			Founded	
Address	No. 2, Caiyuanjia, Xuanwu District, Beijing TEL: 330891 FAX:			Size: Lot–10,000 m^2 Lot– 960 m^2	
Employees	Total personnel Technical staff	800 130 80 (IC)	Procurement 50% of resins and lead wires procured domestically 100% of chemicals and pure water procured domestically	Capitalization –	
Products	ICs for color TTL Diodes Transistors	DIP: 16p, 18p, 30p, 48p		Areas emphasized	
Manufacturing lines	Upstream processes Downstream processes Degree of cleanness	Diodes, transistors 2 shifts/day	Manufacturing capabilities No. 1 in Beijing No. 4 nationwide	1993 10 million units (5 million units)	1995 30 million units (Planned) Plan to invest US$2 million
Equipment	5 Japanese AWB Co. S 2 Co. T Testers (U.S. made)		• Currently planning to invest in new equipment (current equipment installed in 1985)		
Overseas exchanges	Currently considering taking on a new partner				
Tour impressions	Downstream processing focuses on TV ICs and discrete devices, but at a level that calls for drastic measures.				

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5.7.3 Tieups with Overseas Firms

Table 5.7.3.1 Foreign Capital Companies

Joint venture		Chinese company/agency	Overseas company/agency	Description
Sanyo Semiconductor Co., Ltd., founded 1984	Shekou	Wholly owned	Sanyo Corporation	Downstream: transistor assembly
Shougang-NEC Electronics Co., Ltd., founded at end of 1991	Beijing	Capital Steel Co. (60%)	NEC (40%)	Downstream: 4MDRAM (spring 94) Upstream: 6" wafers (fall 94) Memory, MCU, consumer product, switching equipment ICs
Shanghai Philips Semiconductor Co., founded 1991	Shanghai	Shanghai Radio Plant 7 (49%)	N.V. Philips (51%)	Upstream: bipolar 5" CMOS ICs for audio and TV
Motorola Electronics Co., Ltd., founded 1992	Development region of Tienjin	Wholly owned	Motorola	Downstream: discrete devices (1992 on)
China Huajing Electronics Co., founded 1992	Wuxi	China Huajing Electronics Group	Atmel	Upstream: bipolar CMOS 2 µm
	Wuxi	China Huajing Electronics Group	Siemens	Upstream: bipolar CMOS 2 µm
Shanghai Beiling Microelectronics Mfrg. Co. Ltd., founded 1988	Shanghai	Shanghai Radio Plant 14 (60%)	Shanghai Beiling Microelectronics (40%)	Upstream: CMOS 4" 2-3 µm ICs for telephone communications, clocks, MCU and TVs
Electronics Dalian Co., Ltd.	Dalian	Wholly owned	Lome [phonetic] (25%) Lome Kanboku [phonetic] (75%)	Hybrid ICs
Beijing Hamamatsu Photonics Technology Co.	Beijing	Beijing Nuclear Instruments Plant	Hamamatsu Photonics (50%)	Photoelectric transfer devices
China Ling Lang Microelectronics Computer Co. founded 1985	Guangzhou	Guangdong government	Ling Lang Microelectronics Investment Co. (U.K.)	IC MPU
Under consideration	Jiangsu Province		Intel	Downstream MPU
Under consideration	Shanghai		Matsushita Electronics Industries Co., Ltd.	Downstream ICs for VTRs
Under consideration	Wuxi	China Huajing Electronics Group	Toshiba Corp.	Downstream: ICs for TVs and VTRs bipolar ICs
Under consideration	Shanghai	Shanghai Electronic Measuring Equipment Industry Bureau	Northern Telecom	Design center IC plant 1 µm (1994 on) ASIC
Under consideration			TI	Design base Dedicated ICs for Chinese-English translation Image processing

*AT&T and others are also considering entering the market

Source: EIAJ Survey Team

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5.8 China's Semiconductor Industry: Problems and Outlook

5.8.1 Problems Facing China's Semiconductor Industry

(1) Distributed Operations, Small Scale, Low Productivity

There are roughly 340 semiconductor manufacturers distributed throughout the vast expanse that is China. Most of these operations are small scale and suffer from low productivity. The Chinese government is attempting to attract foreign capital and is promoting the centralization of semiconductor manufacturing operations in order to expand the scale of these operations, but it appears that the restructuring of regional state-run enterprises is not going so well.

(2) Low-level Production Technology and Manufacturing Equipment

China's semiconductor mass production technology is currently at the level where 3- to 5-inch wafers and 2- to 5-micron geometries can be turned out in volume. Compared to the 8-inch wafers and 0.5-micron feature sizes being mass produced in Japan and other advanced countries, China's technology lags about 10 years behind.

The reasons for this gap include problems related to China's original level of technology in this field, plus the difficulties experienced purchasing advanced equipment under the COCOM restrictions and the fact they have been forced to use obsolete manufacturing equipment and facilities as a result.

(3) Semiconductor Industry's Incomplete Infrastructure (Electric Power) and Immature Peripheral Industries (Equipment, Parts and Materials)

China's semiconductor peripheral industries are very immature, and its semiconductor manufacturers must rely almost entirely on imports for their required equipment, parts and materials. Consequently, their costs are higher and maintenance is expensive. As far as the semiconductor industry's infrastructure is concerned, although the promotion of a large-scale electric power project is showing signs of improving the situation somewhat, power supply cannot keep up with increases in demand, and it will most likely be some time before stable energy supplies are available.

5.8.2 Potential for the Development of China's Semiconductor Industry

(1) Governmental Policies Regarding the Semiconductor Industry

Beginning with its Seventh Five-Year Plan, the Chinese Government designated the semiconductor industry as one of the industries it intended to cultivate on a priority basis, and has been supporting this industry by promoting the formulation and implementation of policies favorable to its growth and development.

(2) Huge Internal Demand for Electronic Equipment

China has a population of 1.2 billion people, and demand for electronic equipment will be huge in future. China is steadily expanding the production of various electronics equipment to meet this demand. Demand for semiconductors inside China worked out to ¥102.7 billion in 1992 and is expected to reach ¥196.3 billion by 1995, reflecting an average annual growth rate of 24%. This combined with growing regional demand will make the Chinese market for semiconductors the No. 1 growth market in the world.

(3) Strong Links Between the Semiconductor and Electronic Equipment Industries

Most of the semiconductors manufactured by China's semiconductor makers are supplied to electronic equipment manufacturers for use in domestically-produced color TVs, thus forming strong links between the semiconductor and electronic equipment industries. This differs from the export-oriented semiconductor industries that grew up in ASEAN in the past. ASEAN countries opted to rely on big foreign capital firms for downstream processing of semiconductors as a means of acquiring foreign currency, but this approach weakened the links between ASEAN semiconductor industries and domestic electronic equipment makers. But internal demand for semiconductors in China will probably expand in direct proportion to that country's expansion of TV production.

(4) Outstanding Semiconductor Design Capabilities

Although China's semiconductor industry lags markedly behind in the areas of manufacturing technology and productivity, it possesses considerable IC design and other CAD software development capabilities.

5.8.3 Future Outlook

This section compares China's semiconductor industry with those in South Korea, Taiwan and ASEAN to give us a better look at where it stands now and what the outlook for the industry is in future.

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Table 5.8.3.1 Special Characteristics of Semiconductor Industries in South Korea, Taiwan and ASEAN

Type	Characteristics
South Korean	• Large-scale, integrated production of primarily memory devices by government-supported Korean zaibatsu. • Main emphasis on exports, with little going to meet internal demand.
Taiwanese	• Government-guided, with small-scale upstream and downstream processing.
	• A foundry business that produces mainly ASICs slated for internal consumption (PC-related).
ASEAN	• Large-scale, foreign-capital-dominated, downstream-oriented. • Primarily export in nature, with small amounts of semiconductors slated to meet internal demand.

Prior to the introduction of foreign capital, China's semiconductor industry had spawned small-scale state-run enterprises that produced ICs mainly for use in domestically-manufactured consumer products (color TVs), and therefore closely resembled the type of development exhibited by Taiwan's semiconductor industry. However, China's semiconductor industry has recently evidenced a desire to break away from the Taiwanese format of the past and race to catch up with South Korea and ASEAN by energetically promoting the introduction of foreign capital and expanding the scale of its operations. But China's semiconductor industry differs significantly from those in South Korea and ASEAN in that whereas the latter two were forced to pursue an export-driven approach in order to develop and grow, China possesses the latent ability to expand its huge internal demand. In the mid-term, China has the potential for developing its semiconductor industry on its own, a format heretofore unseen in Asia. More specifically, it is felt that China will allow the foreign capital joint ventures to play a leading role in promoting the development of a semiconductor industry targeted at China's internal markets. In future, this approach should weed out most of the small- to medium-size, low-productivity state-run enterprises.

As for the long-term outlook, in addition to targeting internal demand, China's semiconductor industry also has the potential for developing into an export base along the lines of ASEANs semiconductor industries. However, in line with moves designed to increase the scale of semiconductor operations, problems related to China's unique distribution system could surface. The strong possibility also exists that China will be forced to change its policies regarding the semiconductor industry in future once it gains membership in the GATT and/or following the return of Hong Kong. When that happens, China will probably have to take another look at the positioning of its semiconductor industry from an Asia-wide logistics standpoint, i.e. one that includes other Asian nations.

Conclusions

Political and Economic Trends

At the third session of the 14th Party Congress of the Chinese Communist Party, held from 11-14 November 1993, a vote was taken on Item 50, Chapter 10 "Decisions of the Party Congress on Slight Problems Related to the Establishment of a Socialist Market Economy System," which, it is felt, could put an historic end to the future of the socialist market economy system in China.

It is worth taking note of the fact that fifteen years after the reinstatement of Deng Xiaoping at the third session of the 11th Party Congress held in 1978, the Chinese authorities announced a plan of action for reform and openness (a market economy system). This action plan can be seen as a kind of last will and testament by Deng himself for the future of post-Deng China.

The specifics of this action plan are as outlined below:

1. Set forth provisions for matching up a market economy system with the basic principles of socialism
2. Establish a modern corporate system by restructuring the management of the state-run enterprises
3. Beginning with product distribution, cultivate the financial and real estate elements of a market system
4. Establish a system for controlling the macroeconomic forces by reforming government agencies, as well as the taxation and financial systems
5. Achieve rational individual income distribution and a social security system
6. Raise the standard of living of the farmers and promote the development of the countryside
7. Deepen the reform of the socialist economic system and further expand the open door trade policy with other nations

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8. Promote the merger of science and technology with the economy, and reform the education

9. Create and maintain a legal system designed to foster honesty and prevent corruption

10. Strengthen Communist Party guidance and establish a socialist market economy system by the end of this century.

If China can achieve these objectives, as was pointed out in a report published last year by the World Bank, the Chinese economic sphere could well become the world's fourth leading economy following those of the United States, Japan and Europe.

On the flip side of the coin, however, the economic prominence of the outlying cities could raise the specter of regionalism, which, in a worst case scenario, could lead to a third Tienanmen Incident.

In any event, judging from the posture of the Chinese authorities and the lifestyles of the Chinese people, it is clear that China's socialist market economy system has reached the point of no return.

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